Instruction Manual

MODEL-M7C8-100 OV

SUPER MERCURY SERIES

TRANSISTORIZED POWER SUPPLY

TRYGON Power Supplies

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TRYGON ELECTRONICS
SUBSIDIARY

SYSTRON DONNER
CORPORATION

1200 Shames Drive, Westbury, N.Y. 11590 (516) 997-6200

MODEL-M7C8-100 OV

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NOTICE

This Instruction Manual provides general characteristics, operating procedures, theory of operation, maintenance and calibration procedures and includes a complete schematic, and parts list pages for the model(s) listed on the front cover.

Any questions concerning this documentation should be directed to the Publications Dept., Trygon Electronics Inc., 1200 Shames Drive, Westbury, N.Y. 11590

Questions concerning the operation and application of Trygon power supplies should be directed to the Applications Engineering Dept., at the above address.

MEASUREMENT OF REGULATION AND RIPPLE

The specifications cited herein for regulation and ripple can be readily attained on every Trygon power supply, provided the proper method of measurement is employed. The major consideration is that the highly stable meter and oscilloscope, specified in the calibration section test procedures, must be connected to the sensing terminals and not at the load terminals. The reason for this precaution is that the voltage drop between the load terminals and sensing terminals will yield an inaccurate regulation and ripple measurement.

CAUTION

Primary output power should be taken from the rear mounted studs. Front panel jack and rear panel barrier strip connections are for test and control functions only. They are not rated for full output power.

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TRYGON ELECTRONICS
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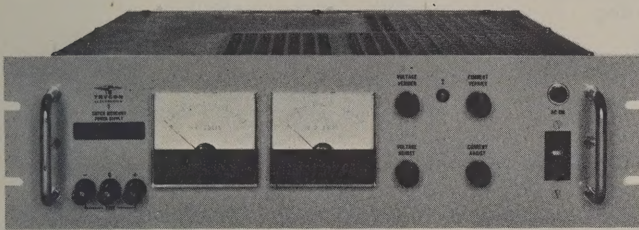
Super Mercury M-C/M-P Series Constant Voltage/Constant Current



M-C/M-P Series

Features

- All Silicon Design — Precision Performance
- Wide Voltage Ranges — Currents to 130 Amps
- Positive Convection Cooling
- Overvoltage Option
- Ultra-High Stability Option
- Automatic Load Share Paralleling
- Master-Slave Tracking
- Remote Sensing and Programming
- No Turn On/Turn Off Transients

Description

Trygon's Super-Mercury series power supplies offer a new level of precision performance featuring constant voltage and constant current operation for military and industrial systems applications. Wide voltage ranges and high currents are available in compact packages with panel height of 3½, 5¼, and 7 inches.

For applications that demand paralleling of supplies, Trygon's Automatic "Load Share" Paralleling is provided as a standard feature. This feature permits interconnection of the supplies so that each supply delivers an equal amount of current to the load, with single knob control of up to four units.

Electrical Specifications

CONSTANT VOLTAGE MODE WITH ADJUSTABLE CURRENT LIMITING

Input:	105-132 VAC, 47-65[1] Hz. (E Model, 200-252 VAC available).
Output:	Floating; isolated from ground, 300 VDC max.
Regulation, Line:	± 0.005% or 2 mV* for 105-132 VAC line change.
Regulation, Load:	± 0.005% or 2 mV*, for no load to full load.
Ripple:	Less than 1 mV RMS; total ripple and noise less than 25 mV P-P or 0.01% (to 10 MHz) (50 mV on 160 V units).
Stability:	0.015% or 3 mV* for 8 hours after 30 minute warm-up. Measured at constant line, load and ambient temperature.
Ultra High Stability Option (X):	0.005% or 1 mV* with a T.C. of (0.005% + 50 μV)/°C. in remote programming.
Temperature Coefficient (Per °C):	0.015% + 100 μV.
Temperature Range:	M-C — 20° to + 60°C. M-P — 20° to + 50°C.
Recovery Time:	50 microseconds to within 0.1% or 50 mV*, for a $\triangle$ I change as shown in the table.
Overload Protection:	Automatic adjustable current limiting variable from 1% to 100% of rated current. Front panel mode indicator and thermostatic thermal protection.
AC Power Input Protection:	(3½" units) fuse, all other models are protected by circuit breakers.
Programming Capability: Voltage Mode:	Resistance; 100 ohms/volt ± 1% Voltage; 1 volt/volt.
Remote Sensing:	Maintains rated regulation directly at the load. Maximum line drop 1 volt per leg. (.0.5V M-P units).
Voltage Adjustment Range:	Continuously adjustable over rated voltage range. Resolution and settability 0.02% or 3 mV*
Paralleling:	Automatic load share paralleling with single knob control of up to four units, is standard on all models except M7C5-130 OV.
Master-Slave Tracking (Opposite Polarity, M-C Units Only):	0.01% or 3 mV* for line, load, or ± 1 V master change. 0.1% or 30 mV* from 25% to 100% of master range. 1% or 100 mV* from 0 to 25% of master range.
Overvoltage Protection: (Internal Option)	Automatic fast acting overvoltage protection tracks the preset output voltage and automatically resets upon removal of the OV condition.

1. Derate for 50 Hz operation:
   (M3P: derate current 20% or temp. 10°C)
   (M5P: derate current 10% or temp. 10°C)
   (M-C: derate current 10% or temp. 10°C)

*Whichever is greater.

CONSTANT CURRENT MODE WITH ADJUSTABLE VOLTAGE LIMITING

Current Range:	Continuously adjustable from 1% to maximum. Resolution and settability 0.02% or 3 mA*.
Voltage Compliance:	0 to rated output voltage.
Regulation, Line:	0.02% I max + 1 mA for 105-132 VAC line change.
Regulation, Load:	(0.05% I max + 5 mA) $\frac{\triangle V}{V\,max}$
Ripple:	0.05% I max or 5 mA*.
Stability (M-C Units):	0.03% I max + 5 mA for 8 hours after warm-up. Measured at constant line, load and ambient temperature.
Stability (M-P Units):	0.05% I max + 10 mA for 8 hours after warm-up. Measured at constant line, load and ambient temperature.
Temperature Coefficient (Per °C) (M-C Units):	0.03% I max + 2 mA.
Temperature Coefficient (Per °C) (M-P Units):	0.05% I max + 4 mA.
Remote Programming:	Programmable over output current range (linear). Programming resistance Linear $R_{pgm} \approx$ 500 ohms/I full scale.

General and Physical Specifications

Design Principle:	M-C; Phase Controlled Pre-regulation with Precision Series Pass Regulation. M-P; Precision Series Pass Regulation.
Operational Modes:	Constant Voltage with adjustable current limiting and Constant Current with adjustable voltage limiting — automatic crossover, automatic load share paralleling, master slave tracking (M-C only).
Mode Indicator:	Front panel mode indicator light indicates when supply is in overload or constant current condition.

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Controls:

Voltage:	Coarse and vernier voltage adjustment, front panel.
Current:	Coarse and vernier Current adjustment, front panel.
Input Power:	Front panel circuit breaker and power indicator.
Current Balance:	Rear panel adjustment for auto-load share paralleling.
OV Adjust:	Rear panel adjustment potentiometer for OV. Automatic reset.

Metering: Non-metered (NM) version available.

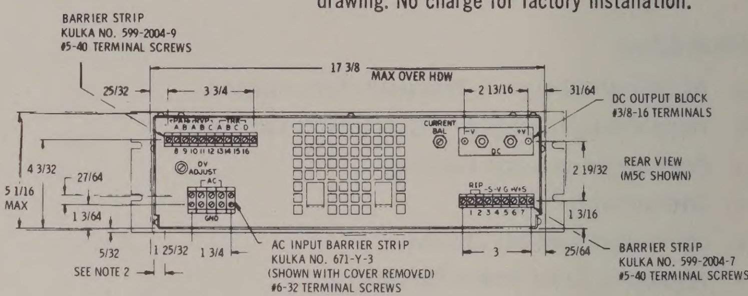
Voltage:	Front panel voltmeter (2% FS Accuracy).
Current:	Front panel ammeter (2% FS Accuracy).

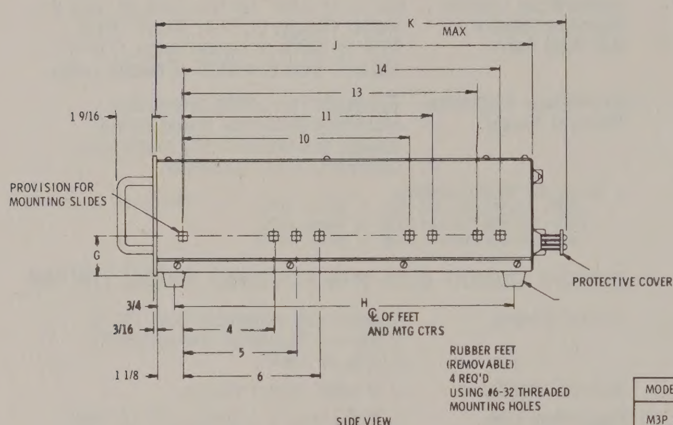
Connections:

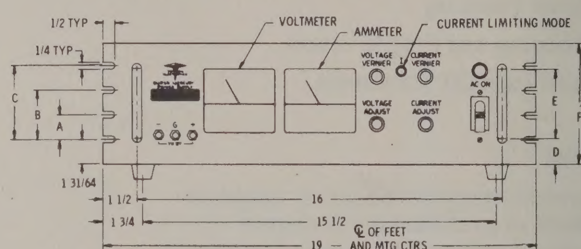
Front Panel:	Monitoring test jacks.
Rear Panel Power Output Terminals:	⅜-16 heavy duty terminals for + V and — V, except M3P which has ¼-20 terminals.
Rear Panel: Barrier Strip:	(1-2) Remote Current Programming RIP; (3) Negative Sensing — S; (4) Negative Output — V; (5) Ground G; (6) Positive Output + V; (7) Positive Sensing + S; (8-9) Auto Load Share Paralleling PAR; (10-11-12) Remote Voltage Programming RVP; (13-14-15-16) Master Slave Tracking M-C|Units Only TRK. AC input with Protective Cover AC.

Universal Slide Mounting: Integral provisions are made for rapid mounting of commonly specified, centerline mounting, slide assemblies (in-line screw centers). Typical slide assemblies are Emcor series 20, Grant series 4435 and Jonathan series 120 qd. ½″ flush strips provided on bottom.

To utilize slides, add snap-in mounting nuts Tinnerman type C7931-632-3B (6/32″), C7931-832-3B (8/32″), C7931-1032-3B (10/32″). When ordering, specify nut size and positioning per outline drawing. No charge for factory installation.







MODEL	A	B	C	D	E	F	G	H	J	K
M3P SERIES	3	—	—	9/16	2 3/8	3 15/32	1 3/4	15	16 9/16	17 3/4
M5C SERIES	2 1/4	—	—	1 1/8	3	5 7/32	1 3/4	15	16 9/16	18 1/16
M7C SERIES	4	—	—	1 3/8	4 1/4	6 31/32	3 1/2	15 33/64	17 1/8	18 1/4

NOTES:

1. ALL DIMENSIONS ARE IN INCHES.
2. UNITS ARE PROVIDED WITH 1/2" MIN. CLEARANCE ON EITHER SIDE OF CHASSIS BOTTOM FROM FRONT TO REAR FOR FLUSH RAIL STRIP MOUNTING.

Model	Volts[1]	Amps	Impedance[2] DC-1 kHz, Ohm	Recovery △ I[6]	Panel[3] Hgt. In.	Weight lbs.	AC Line Current Rms Amps[5]	Eff (%)[4]
M7C 5-130 OV	0-5	0-130	0.001	20	7	120	15.4	45
M3P 8-25 OV	0-8	0-25	0.001	20	3½	50	5	45
M5P 8-50 OV	0-8	0-50	0.001	20	5¼	80	8	43
M7C 8-100 OV	0-8	0-100	0.001	20	7	120	22	49
M5P 15-30 OV	0-15	0-30	0.001	10	5¼	80	8	60
M5C 15-50 OV	0-15	0-50	0.001	10	5¼	80	16½	62
M7C 15-80 OV	0-15	0-80	0.001	10	7	120	27	60
M5P 36-15 OV	0-36	0-15	0.002	10	5¼	80	9	63
M5C 40-30 OV	0-40	0-30	0.001	10	5¼	80	19	69
M7C 40-50 OV	0-40	0-50	0.001	10	7	120	35	66
M5P 60-10 OV	0-60	0-10	0.004	10	5¼	80	10	68
M5C 60-15 OV	0-60	0-15	0.002	10	5¼	80	14½	77
M7C 60-30 OV	0-60	0-30	0.001	10	7	120	30	74
M5C 160-5	0-160	0-5	0.003	3	5¼	80	13½	84
M7C 160-8	0-160	0-8	0.002	3	7	120	22	79
M7C 160-15	0-160	0-15	0.001	3	7	140	43	75

Prices for these models range from $445 to $1645.

[1] In remote sensing mode, maximum available output is reduced by sensing drop.
[2] Nominal.
[3] All units, width: 19″
[4] Efficiency at 115V and maximum output.
[5] AC line current at nominal input 115V, reduced to ½ for 230 VAC input.
[6] 10% load I minimum.

SECTION 1

DESCRIPTION

1.1 INTRODUCTION

The Super-Mercury series power supplies are flexible and dependable sources of DC power, which can be used to meet a variety of needs. These needs may range in scope from inspection and production testing, to laboratory bench testing, IC and systems applications.

The wide range of outputs available makes these units well suited for use as a basic laboratory power source. The ability of the Super-Mercury series to provide power packaged in minmum space with high reliability and performance meets the demands of most systems requirements.

Super-Mercury series units are available in two versions, M-P and M-C. The basic difference between the two being that the M-C series units have preregulation.

All components used in the construction of the Super-Mercury series units are of the highest quality available and have been subjected to rigorous incoming inspection procedures.

Automatic tracking overvoltage protection (TOV) option is available for the M-C units only.

Each electrolytic filter capacitor is of computer grade and has been quoted by the manufacturer as having a life expectancy exceeding ten years. All silicon transistors have been derated and temperature aged to provide high reliability. All rectifiers are hermetically sealed silicon units and all zener diodes have been temperature stabilized.

1.2 GENERAL FEATURES

Output, sensing, automatic "Load Share" paralleling, Master-Slave tracking (M-C only), and remote programming terminals are located on barrier strips mounted on the rear panel of the unit. The AC power switch, AC pilot lamp, overload indicator lamp, current and voltage controls and appropriate metering devices are all located on the front panel.

Constant Voltage Mode

A constant voltage is maintained across the output terminals at any preset value from zero to rated voltage output, provided that the load does not draw more than either the rated output current or more than the preset limiting current value determined by the front panel current control setting.

Constant Current Mode

Constant current operation is featured in all of the Super-Mercury models. Constant current operation is achieved by maintaining a constant voltage across an internal current sensing resistor. An automatic crossover network changes the mode of operation from Constant Voltage to Constant Current when the current demand reaches that of the pre-set current adjust control. The point at which the operating mode automatically changes is a function of variations in load conditions. The crossover point is adjustable and can be established anywhere within the current and voltage range of the unit. A mode indicator light on the front panel will indicate when the supply is operating in the constant current mode.

Automatic Current Limiting

Short circuit protection is provided in both by the Automatic Current Limiting circuit which limits the maximum output current under all load conditions. The point at which automatic current limiting occurs is variable, and may be selected anywhere from 1% to the rated output of the unit. In the event of a short circuit, the output voltage drops to zero and returns to normal only when the short circuit is removed.

Remote Programming

Remote programming is provided in both the voltage and current mode of operation and may be utilized over the entire range of the unit. The scale factor for remote voltage programming is approximately 100Ω's per volt, remote current programming is a linear function of 500Ω's for maximum current.

Automatic "Load Share" Paralleling

Automatic "Load Share" paralleling permits interconnection of up to four supplies so that each supply in parallel can deliver an equal or proportional amount of current to the load, with single knob control of all units.

Master-Slave Tracking (M-C units only)

This feature provides for two M-C units to be connected as (+) and (-) outputs with a common, and the (+) output becoming a Master supply. Any change in the output of the Master supply due to voltage control changes, line or load regulation will automatically be reflected in the negative output of the other Slave unit. Refer to the data sheet for tracking tolerance specifications.

Adjustable Overvoltage Protection (OV) (Optional Feature)

Adjustable overvoltage (OV) protection is available as an option on all units except the M3P8-25 OV, M5P8-50 OV and M7C8-100 OV where overvoltage protection is included as a standard feature. This option provides for special circuitry which prevents the output from exceeding a preset voltage. An external adjustment control (mounted on the rear panel) is provided to vary the point at which the OV circuit will activate.

Tracking Overvoltage Protection (TOV) (Optional Feature M-C Units Only)

Tracking overvoltage protection requires no readjustment of the overvoltage protection point. As the output voltage is varied either by local or remote programming the protection level automatically tracks to stay approximately 10% or 1.5 volts above the output voltage.

1.3 PRECAUTIONARY MEASURES

Wire Size

To assure proper regulation under all load conditions and to prevent severe distortions of the AC line voltage, it is very important to take into consideration the physical size and current handling capabilities of the input power line. Serious losses in regulation and an increase in ripple may result from underrated or overload AC input lines. The maximum AC impedance from the breaker box to the power supply should not exceed .075Ω's.

Systems Considerations

In systems applications it is recommended that each power supply input power line be run separately to the AC distribution box in order to minimize cross coupling and interaction between equipment. Do not run sensitive signal leads such as the remote sensing leads in the same cable as the AC input without shielding. To keep the AC ripple in the output to a minimum, it is recommended that the AC input cables not be run in close proximity to the output load cables.

Terminal Post Resistance

All terminals and shorting links serving outputs, sensing and programming must be securely tightened before use. Serious loss of regulation and an increase in ripple can result due to a voltage drop caused by loose terminals and shorting links. (See Warning Note on title page.)

SECTION 2

INSTALLATION AND OPERATION

2.1 MECHANICAL INSTALLATION

When the Super-Mercury series power supply is used in a rack or bench type configuration, no special mechanical installation is required. Integral slide mount provisions are included for rapid mounting of commonly specified centerline mounting, slide assemblies (in-line screw centers).

2.2 ELECTRICAL CONNECTIONS

Input Power

A three-terminal barrier strip mounted on the rear panel provides AC input connections to the unit.

The power handling ability of the AC power lines feeding AC power to the unit must be considered as serious losses in regulation and substantial increase in ripple may occur as a result of insufficient power capacity of these lines. All AC power line connections must be securely tightened and any movable electric contact surface (such as the wiper arm of a variable transformer) should be kept clear of impedance producing oxide coatings.

Care should be exercised in selecting the proper wire size for the AC input lines. The figures listed in Table 2-1 will serve as a guide in making this selection.

TABLE 2-1 - AC INPUT WIRE SIZE

Length of Run (Single Lead)	Wire Size (AWG Standards)
10 Feet or less	8
10 feet to 20 feet	6
20 feet to 50 feet	4
50 feet to 100 feet	2

Output, Rear Panel

Rear Panel terminal barrier strips provide sensing, programming, automatic "Load Share" paralleling Master-Slave Tracking (M-C Only) and ground connections. A heavy duty block containing two (2) stud type terminals is provided for output connections.

Output, Front Panel

Three (3) way jack binding post terminals mounted on the front panel provide output and ground connections.

These terminals are provided primarily for convenience purposes and for easy monitoring of the output. THEY SHOULD NOT BE USED TO DRAW LOAD CURRENT. To achieve optimum regulation, connections should be made to the output block mounted on the rear panel.

2.3 OPERATING CONFIGURATIONS

The Super-Mercury series power supplies are designed to operate as highly regulated constant voltage/constant current sources with automatic adjustable current limiting. There are various operating configurations that can be used by proper application of shorting links and wiring. The following paragraphs describe the various operating configurations and their connections.

Local Voltage Programming (Fig. 2-1)

To adjust the output voltage from the power supply, connect a shorting link across terminal 11 and 12. With this shorting link installed, the voltage adjust controls provide adjustment of the output over the rated voltage range.

Remote Voltage Programming (Fig. 2-2)

Remote voltage programming is achieved by removing the shorting link from terminals 11 and 12 and placing it across terminals 10 and 11 and substituting a remotely operated adjustment control across terminals 11 and 12, of a value equivalent to 100Ω's per volt of required output voltage.

Local Current Programming (Fig. 2-1)

To adjust output current from the power supply, connect a shorting link across terminals 1 and 2. With this shorting link installed, the current adjust controls provide the current limiting required.

Remote Current Programming (Fig. 2-2)

To adjust the output current remotely, disconnect the link from across terminals 1 and 2 and substitute a potentiometer of 500Ω's across terminals 1 and 2. The output current will be linearly proportional to 500Ω's for rated current output. Zero ohms will be equal to nominal zero current. Since the front panel current adjust controls are in series with the remote control, they should be turned completely CCW to eliminate their resistnace contribution.

Sensing Connections

Local Sensing (Fig. 2-1)

Local sensing connections are made when rated regulation is not required directly at a remote load. Connect the load to output studs (+V) and (-V), and ascertain that shorting links are connected between terminals 3 and 4 and 6 and 7.

Remote Sensing (Fig. 2-3)

Remote sensing is used when rated regulation is required at a remote load.

Remove the shorting links between terminals 3 and 4 and 6 and 7. Using a twisted, shielded pair of wires, connect the -S (3) and +S (7) sensing terminals to the load. To prevent damage to the power supply, correct polarity of both the remote sensing and output leads must be observed. The negative remote sensing lead (-S) and negative output lead (-V) must be connected to one side of the load and the positive remote sensing lead (+S) and the positive output lead (+V) connected to the other side of the load. The shield should be grounded at the power supply end of the cable.

AUTOMATIC LOAD SHARE PARALLELING (Fig. 2-4)

General

To operate two or more power supplies in the automatic load share paralleling mode, select one unit as a master and the other units as slaves. Set the front panel controls on the slaves fully CW and disconnect the jumper between terminals 8 and 9. With the jumper on the master connected between terminals 8 and 9, connect terminal 8 on the master to terminal 9 on all the slaves.

Use leads of approximately equal resistance for connecting load to (+V) terminals, or strap (+V) terminals directly together if near each other and use a single lead from the master terminal.

Remote sensing need only be done with the master terminals. Remove jumpers from between terminals 3 and 4, and terminals 6 and 7 on master and run leads from 3 to (-) side of load and from 7 to (+) side of load. Leave jumpers in place on slave unit.

To balance the load sharing, rotate R42 on rear panels, (current balance) CCW. Turn units on and adjust load to maximum. For units indicating larger currents, rotate R42 CW until the currents balance. The master unit will now control the output voltage of all the units.

Master-Slave Tracking (M-C Units Only)

To connect two M-C Super-Mercury units in a Master-Slave tracking configuration refer to Figure 2-5 for interconnections required.

Note that the Master unit can be remotely programmed for voltage if required.

This configuration can also be used for series operation of two units as long as the common point is left ungrounded. See Series Operation following.

Series Operation

To operate two or more power supplies in a series configuration, connect the output of each supply in series. It is necessary to adjust the output of each unit independently, unless the Master-Slave configuration above can be utilized (See Fig. 2-4).

More than two supplies may be so placed in series not exceeding 300 volts with individually adjusted outputs.

To remote program units in simple series it is necessary for an individual programming resistor to be used with each supply. These resistors must be kept insulated from one another.

2.4 CONTROLS

Front Panel

All front panel controls are listed in Table 2-2

TABLE 2-2 FRONT PANEL CONTROLS

Name	Function
AC ON	Toggle switch, controls input power
VOLTAGE ADJUST (coarse)	Potentiometer, adjusts voltage output
VOLTAGE ADJUST (vernier)	Potentiometer, adjusts voltage output
CURRENT ADJUST (coarse)	Potentiometer, adjust current
CURRENT ADJUST (vernier)	Potentiometer, adjusts current

Internal

All internal control setting have been factory preset and require no additional adjusting. However, if it should become necessary to adjust any of the internal controls due to circuit changes caused by component aging or replacement, refer to the calibration section of this manual.

2.5 OPERATION

Control Settings

Set all front panel controls fully CW.

Shorting Links

Prior to the application of power, connect all loads, external wiring and shorting links required for the mode of operation desired.

Grounding

Eithor side of the output may be grounded, or the output may be used in a floating condition.

Power On

Connect the unit to an AC input power source. Set AC power ON switch to on, and observe that pilot lamp DS1 glows.

Warm-up

No Warm-up time is necessary to place the unit into operation. However, a 30 minute Warm-up period is recommended to reach rated stability. The unit is now ready for operation.

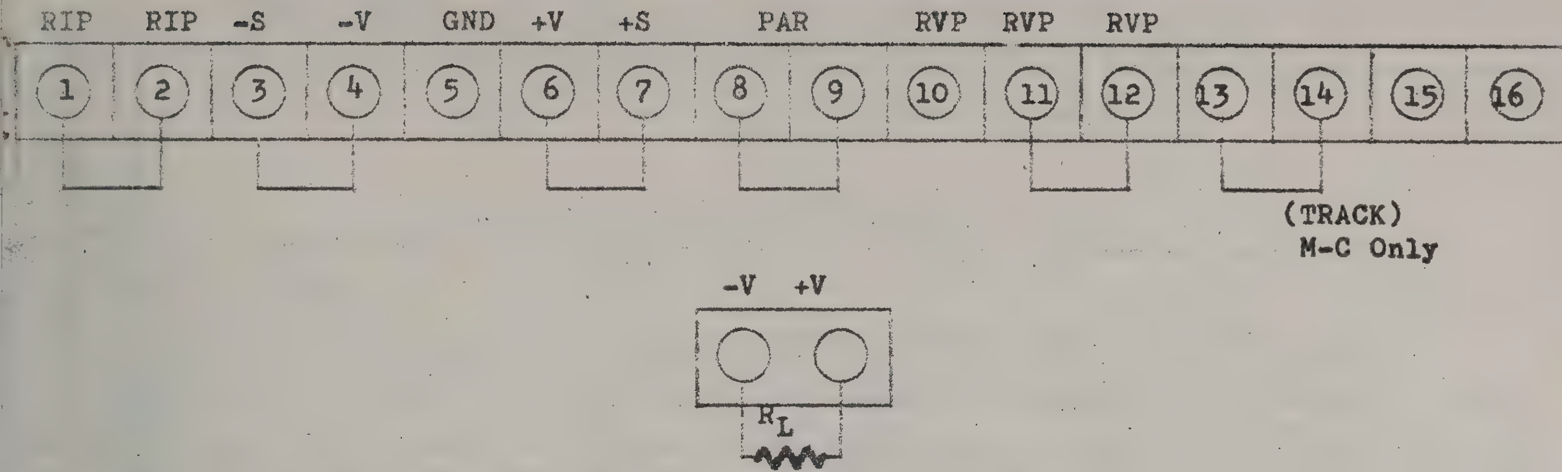


Fig. 2-1 LOCAL PROGRAMMING (Voltage & Current)
LOCAL SENSING

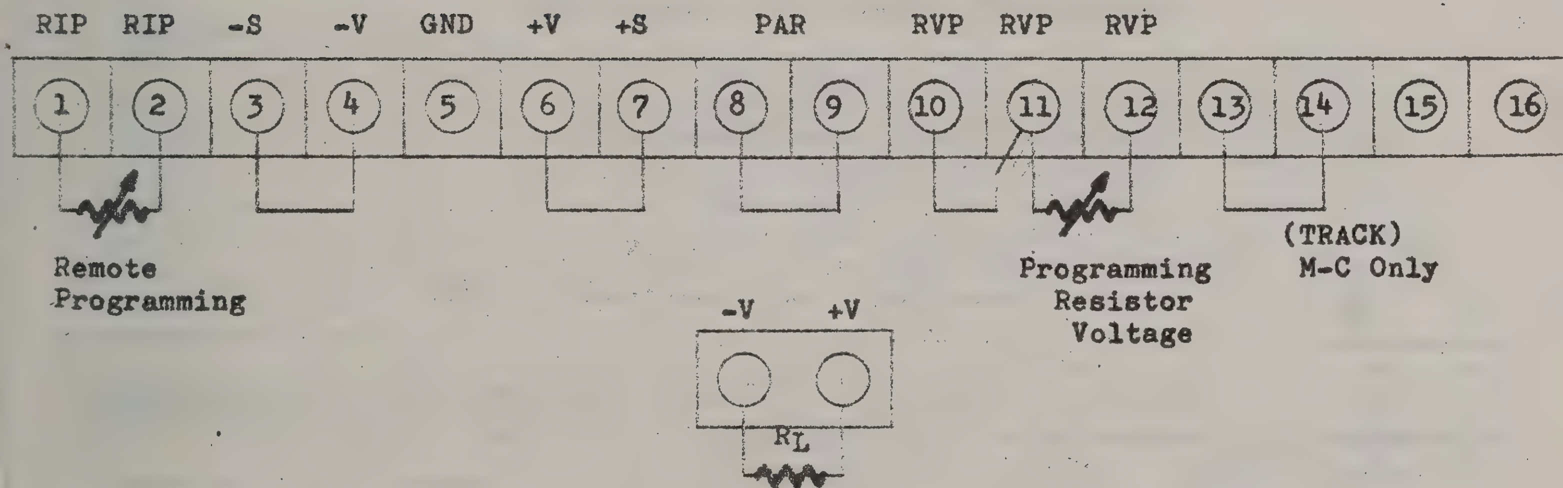


Fig. 2-2 REMOTE PROGRAMMING

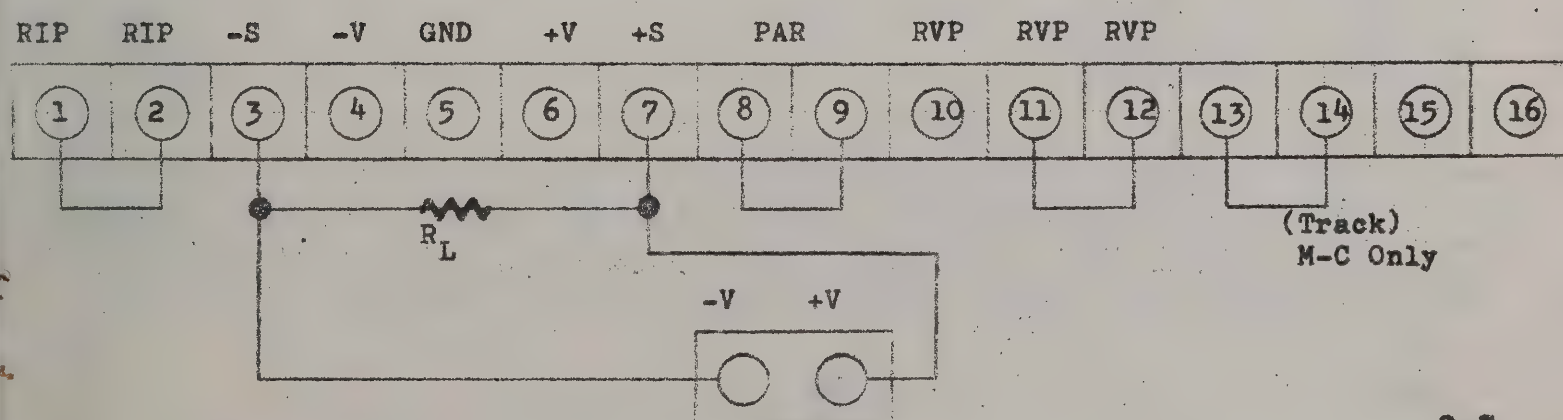


Fig. 2-3 REMOTE SENSING

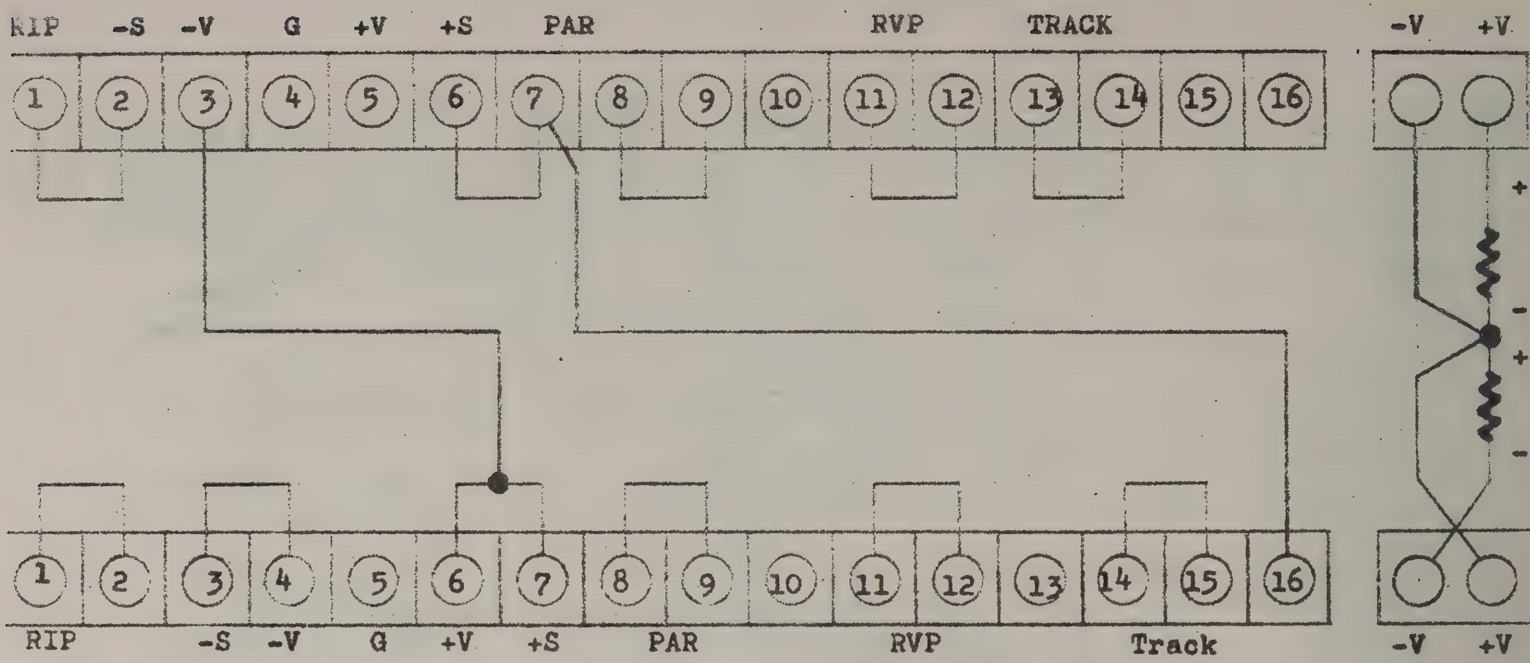


Fig. 2-5

MASTER-SLAVE TRACKING (M-C Units Only)

AUTOMATIC LOAD SHARE PARALLELING

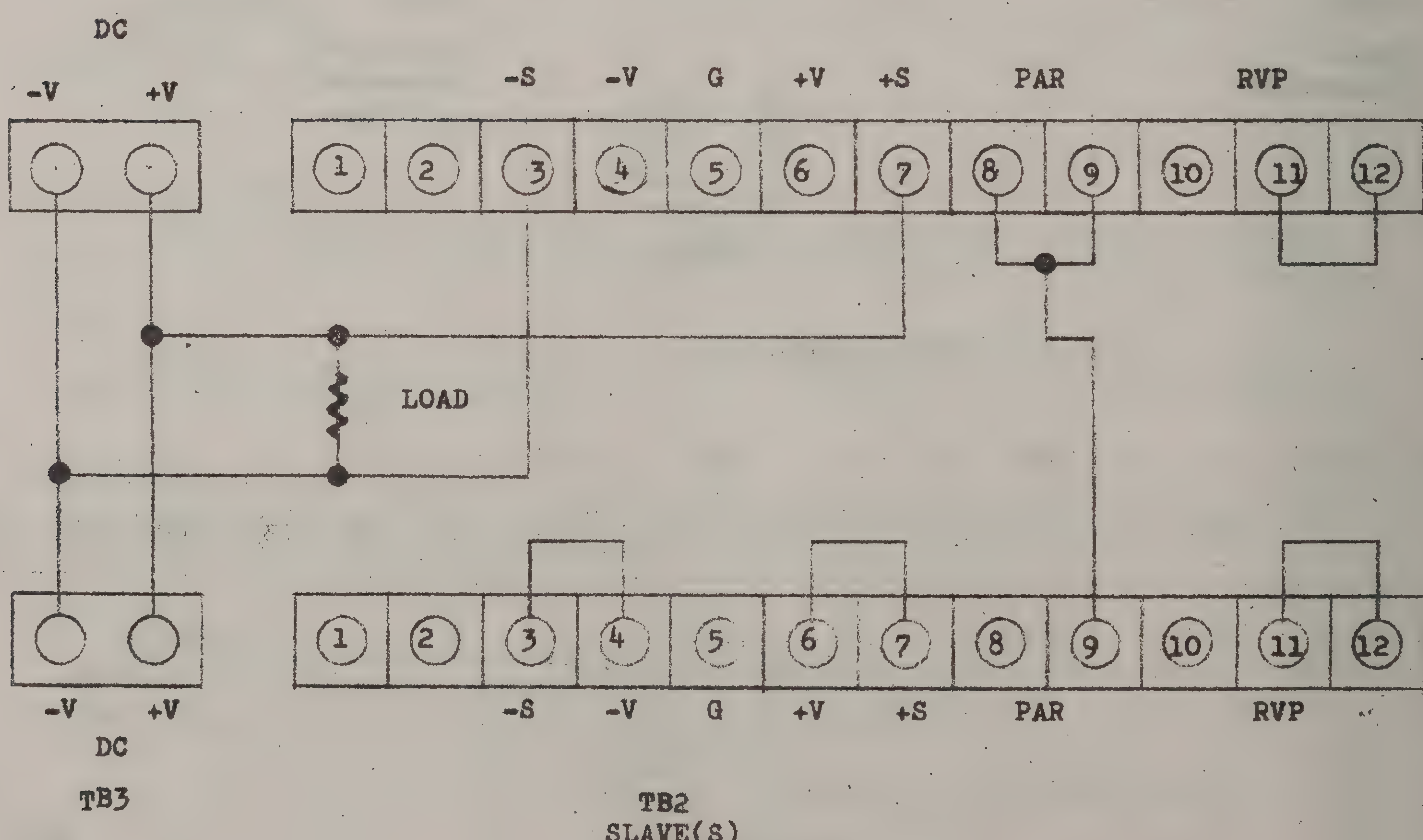


Figure 2-4

SECTION 3

THEORY OF OPERATION

3.1 GENERAL

The purpose of the Super-Mercury series power supplies is to transform and rectify the AC input into a well regulated, stable and adjustable DC output. The following paragraphs describe the major circuits used in these power supplies. As each circuit is described, reference should be made to both the Block Diagram, Fig. 3-1 and the Schematic Diagram in the rear of this manual.

Primary Input

Input power is obtained through the power transformers and their associated diode rectifier and filter circuits. When power switch S1 is set to ON, AC pilot lamp DS1 glows and AC power is applied to T1, T2 and cooling fan B1. Regulated DC output voltage is immediately available from the power supply.

Reference Supply

The purpose of the reference supply is to provide a stable reference voltage for the Comparator and Error Sensing amplifier. Integrated reference amplifier A1 acts as a reference and comparator, sensing any difference in the voltage developed across R1 and zener diode CR12 and the voltage divider composed of R2, R22 and R3 across the output of the reference supply. The error signal is amplified by A1 and the driver amplifier Q2 to vary the sensitivity of Q1 so as to keep the reference voltage across C2 constant.

Pre-Regulator (M-C Only)

The purpose of the pre-regulator is to keep the voltage across the series pass transistors approximately constant. This pre-regulation results in a lowered dissipation in the series pass transistors.

The voltage across the series pass is sensed by the resistance divider (R120, R121, R122, R123) and fed into the base of transistor Q105. Resistors R113, R112 and Q104 make up a voltage reference, to which the series pass voltage is compared. The collector of Q104 supplies a variable constant current source which changes capacitor C102.

When the voltage level across C102 reaches the fixing voltage of the unijunction transistor, Q102 a pulse is produced. This pulse is amplified by the transistor Q101 and fed into the gates of the silicon controlled rectifiers CR21, CR22. The unijunction transistor Q101 synchronized to the input sine wave by the transistor Q100 diodes CR100, CR101 and resistors R101, R104, R105 and R106.

Transistor Q101 generates fixing pulses at controlled points along the input sine wave to keep the voltage across the series pass approximately constant.

Series Regulator

The rectified voltage from the power rectifiers and input filter caps. is directed through the Series Pass transistors. The conduction of these transistors is controlled by circuitry which causes them to act as variable resistors. Their overall resistance varies in accordance with the need of the power supply to increase or decrease its output voltage or current. The Series Pass transistors are controlled by several driver stages which amplify signals from the Error Amplifier.

Comparator and Error Amplifier

The Voltage sensing and comparison is accomplished by an integrated operational amplifier A2. A sample of the output voltage on the base of one side of A2 is compared to the stable reference voltage on the base of the other side of A2. An unbalance caused by a change in voltage at either the negative sensing terminal or across voltage adjustment controls R39 and R40 will appear as a voltage change in A2.

This difference voltage is amplified by A2 and is used to regulate the Series Pass transistors via the Series Pass drivers. A2 has two diode inputs CR6 and CR8. These supply error signals from the current comparator caused by a current limiting condition.

When operating in the Current Limiting mode, differential amplifier Q5 becomes balanced, causing diodes CR6 and CR8 to conduct and drive A2 toward cutoff. This signal also causes Q3 to conduct, thereby causing mode indicator lamp DS2 to glow.

Overvoltage Protection

Overvoltage protection is a standard feature on the 0 to 8 volt Super-Mercury power supplies, and can be provided as an option on all others.

Consult the latest data sheets to ascertain whether Fixed Adjustable overvoltage protection (OV) or automatic tracking overvoltage protection (TOV) is available on a particular model in the series.

Fixed Adjustable Overvoltage Protection

This (OV) circuitry consists of a silicon controlled switch connected between the reference supply, negative power supply output and a voltage divider network. The voltage divider is in series with the reference supply and output. Any change in output will cause a voltage change across the voltage divider.

The adjustment control located on the rear of the supply is a resistor in the divide, and is adjusted so that when the output voltage reaches a predetermined value the silicon controlled switch will conduct, causing an SCR to crowbar the output to nominal zero volts.

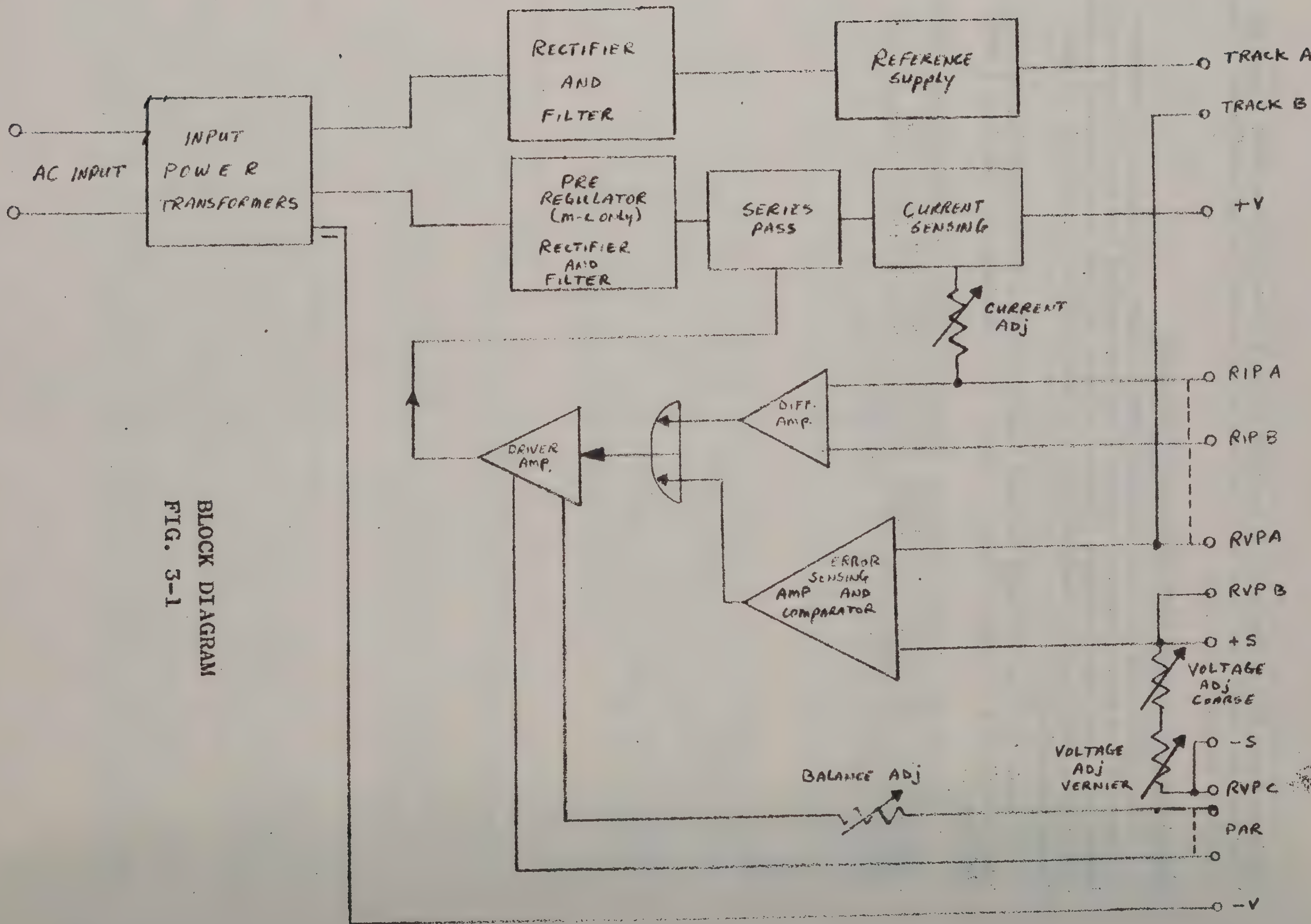
At the same time the drive to the series pass is reduced causing the series pass to turn off, preventing undue large currents from passing through the SCR.

Automatic Tracking Overvoltage Protection

In this type of overvoltage protection circuit a transistor circuit in a non conducting state is connected between the output terminals and the voltage divide network of the programming circuit so that under normal conditions the emitter and base are at the same potential.

Even if the voltage adjust control were to be readjusted the equipotential is maintained. Hence the automatic tracking terminology.

Should the output voltage increase above the programmed value the emitter of this transistor would become more positive than its base causing conduction. This turn-on would in turn trigger an SCR to crowbar the output to nominal zero.



BLOCK DIAGRAM
FIG. 3-1

SECTION 4

CALIBRATION

4.1 GENERAL

The following adjustments should be made when necessary to assure optimum operating characteristics and maximum efficiency of the Trygon Power supply.

4.2 TEST EQUIPMENT REQUIRED (or equivalent)

(A) Oscilloscope, Tektronix Type 561

(B) Differential Amplifier Plug In, Tektronix Type 63

(C) Time Base Plug In, Tektronix Type 67

(D) Differential VTVM, Fluke Model 825A

(E) AC VTVM, Hewlett Packard Model 400D

(F) VOM, Simpson Model 260

(G) Variable Auto transformer, Superior Elect. Co., Type 1156D (20 Ampere rating) for M3 and M5 units. Larger for M7 units.

Shorting Link Application

For test purposes, shorting links should be connected across terminals to provide local sensing and local current and voltage programming. To reduce pick up, shielded wire must be used for all connections between test equipment and the power supply being tested. To prevent ground loops, it is important that only one ground connection be made, as shown in Fig. 4-1 and Fig. 4-2. Tighten all terminal connections as securely as possible, and set all front panel controls fully CW.

4.3 CALIBRATION PROCEDURE

Reference Supply

The reference voltage level is adjusted by means of reference control R22. This potentiometer should be adjusted for a nominal 15 VDC as seen across capacitor C2. All control voltages are derived from this reference voltage. If it is necessary to adjust this voltage, it is very probable that it will be necessary to adjust the following listed sections as well. R22 should be adjusted only if reference zener diode CR12 is changed, or if sufficient output voltage cannot be obtained through the normal operating range of the voltage adjust controls.

Pre-Regulator (M-C Only)

A) With power supply operating without a resistive load across the output terminals, vary VOLTAGE ADJUST control until 50% of rated voltage output is indicated on the D.C. voltmeter. Set AC POWER control to its OFF position, and connect resistive load across the output terminals. Return AC POWER control to its ON position, and adjust resistive load for rated current setting on ammeter.

B) Set oscilloscope to D.C. triggering mode and connect scope input across the positive terminals of the input capacitor and output capacitor.

C) Adjust R121 for a nominal 5 VDC and a balanced 120 cps sinusoidal waveshape.

D) Vary AC input line voltage between 105 and 125 VAC. Observe that the 120 cps sinusoidal waveshape remains balanced and does not vary in amplitude more than 20% of the pre-set value (5 volt nominal).

Voltage Adjust Controls

A) Maximum Voltage Control

Vary voltage controls and observe that output voltage varies as indicated on unit and test voltmeters. Maximum voltage should be approximately 2 to 4 volts above the rated output of the unit. If it is not possible to attain this voltage, Reference Adjust control R22 should be readjusted.

NOTE: If partial rotation of the VOLTAGE ADJUST controls produces no apparent change in indicated output voltage, further rotation of these controls should not be attempted. Rotation of these controls fully CCW with little or no output voltage regulation can result in damage to the controls, the load, or both. Set the AC POWER control to its OFF position, and proceed with the trouble shooting outlined in Section 4 of this instruction manual.

B) Minimum Voltage Check

Set voltage controls fully CCW and observe that the voltage indicated on unit and test voltmeter drops to the zero setting of the meters. If it doesn't, proceed with the troubleshooting outlined in Section 4 of this instruction manual.

Current Adjust Controls

A) Maximum Current

Connect a test ammeter having a full scale current indicating capacity of 150% that of the rated current output across the output terminals of the power supply. (Set all front panel controls fully CCW). Apply power to the unit under test and slowly rotate CURRENT ADJUST and CURRENT VERNIER controls fully CW. Observe that the maximum current obtainable is approximately 110% that of the rated current output.

If it is not possible to achieve 110% of the rated current output, adjust Maximum Current control R24 until that value is attained. Set AC Power control to its OFF position.

Connect a suitable load resistance across the output terminal connections. The load resistance must be able to dissipate the rated power of the unit (P=IE) and must be of sufficient value to yield the rated output current when the rated voltage is applied. Set AC Power control to its ON position. Note the voltage indicated on the Differential VTVM. Disconnect the resistive load from the output and observe the voltage indicated on the Differential VTVM. The maximum change in output voltage should not exceed by more than 0.005% or 2mv (whichever is greater) that of the output voltage indicated with the load resistance applied across the output terminals.

If it is not possible to maintain the load regulation as stated in the preceding paragraph, re-adjust Maximum Current control R24 slightly and re-check the load regulation. Further minor adjustment of Maximum Current control R24 may be necessary to achieve both proper load regulation and 110% of rated current output.

B) Minimum Current

Connect test ammeter, having a full scale current indicating capacity of at least 1% of the rated current across output terminals in place of a load resistor. Set all front panel controls fully CCW and apply power to the unit under test. Slowly rotate VOLTAGE ADJUST control in a CW direction, until current meter indicates a current flow of 1% of the rated current. If this value cannot be obtained, adjust Minimum Current control R23 for the desired current indication.

Constant Voltage Operation

A) Load Regulation

With the equipment connected as shown in Fig. 4-1, connect a suitable load resistance across the Output terminal connections. The load resistance selected must be able to dissipate the rated power of the unit (P=EI) and must be of sufficient value to yield the rated output current when the rated voltage is applied. Note the voltage indicated on the Differential VTVM. Disconnect the resistive load from the output. The maximum change in output DC voltage indicated on the Differential VTVM should not exceed by more than 0.005% or 2 mv (whichever is greater) that of the output voltage indicated with the load resistance applied across the output terminals.

B) Line Regulation

Place the resistive load across the output and note the voltage indicated on the Differential VTVM. Vary the input line voltage between 105 and 132 VAC. The maximum change in output voltage should not exceed by more than 0.005% or 2 mv (whichever is greater) that of the output voltage measured at either extreme of the AC input.

C) Ripple Voltage

In order to reduce pickup, shielded test leads should be used in making ripple measurements. With the resistive load connected across the output terminals, measure the AC ripple with the AC VTVM. Vary the input line voltage between 105 and 132 VAC. The maximum ripple amplitude should not exceed 1.0 mv RMS.

Constant Current Operation

A) Load Regulation

With the equipment turned off, disconnect the resistive load from the output terminals. Connect a small current sensing resistor in series with the resistive load and then connect the load across the output terminals. Selection of the proper value for the current sensing resistor may be easily made using the formula $R_S = \frac{1}{I_R}$ where R_S = Value of Current Sensing Resistor and I_R = Rated Load Current. Connect the equipment as shown in Fig. 4-2, and apply power to the power supply.

Vary the VOLTAGE ADJUST controls and resistive output load as necessary, to achieve rated current and voltage output. Decrease the load resistance until current meter reading exceeds full scale indication. Rotate CURRENT ADJUST control CCW to return the current meter reading to full scale. Observe that the output voltage has decreased from its previous full scale reading and that increasing the VOLTAGE ADJUST controls has no effect upon the output voltage or current. This indicates that the unit is now operating in the Constant Current Mode.

Measure the voltage across the small sensing resistor. Compute and note the current flow through this resistor. Change the output load from the resistive load previously used, to a short. Again measure the voltage across the small sensing resistor and compute the value of the current flow through this resistor. The change in current should not exceed by more than 0.02% of the rated current +3 ma previously noted with a full resistive load across the output.

B) Line Regulation

Replace the resistive load across the output and measure the voltage drop across the small sensing resistor. Compute and note the current low ($= \frac{E}{R}$) through this resistor.

Vary the input line voltage between 105 and 132 VAC. Note the maximum change in voltage across the sensing resistor and compute the maximum current flow. The maximum change in current should not exceed by more than .02% the rated current +1 ma previously noted at either extreme of the AC input.

C) Ripple Current

With the AC input line voltage adjusted to the nominal value of 115 volts and the resistive load connected across the output, measure the amplitude of the AC ripple as seen across the sensing resistor with the AC VTVM.

Compute and note the current flow. Vary the AC input line voltage between 105 and 132 VAC. Measure the maximum voltage drop and compute the maximum current flow. The maximum ripple current must not exceed by more than .05% of the rated current, or 3 ma with nominal input line voltage.

Overvoltage (OV) Sensitivity Tracking OV Only

The sensitivity of the Overvoltage Protection circuit is determined by the setting of Overvoltage Sensitivity control R209. This control is factory pre-set to cause a short circuit to be applied across the output of the unit if the output voltage attempts to rise more than 10% or 1.5 volts above the programmed voltage.

The internal control, R209 is not "solder locked" in place as are the other internal controls, but may be varied to suit the individual needs of the user. This control may be varied from outside the unit by inserting a screwdriver through one of the ventilation holes in the top of the power supply case.

To determine the proper point at which the overvoltage control R209 should be set to automatically shut the unit off, connect the output of a second power supply having a higher output voltage capability, in parallel with the unit under test. Set the output of the second unit 1 1/2 or 10% volts higher than that of the first unit. Adjust R209 until the unit under test automatically shuts itself off.

The fixed adjustable overvoltage option has internal adjustment.

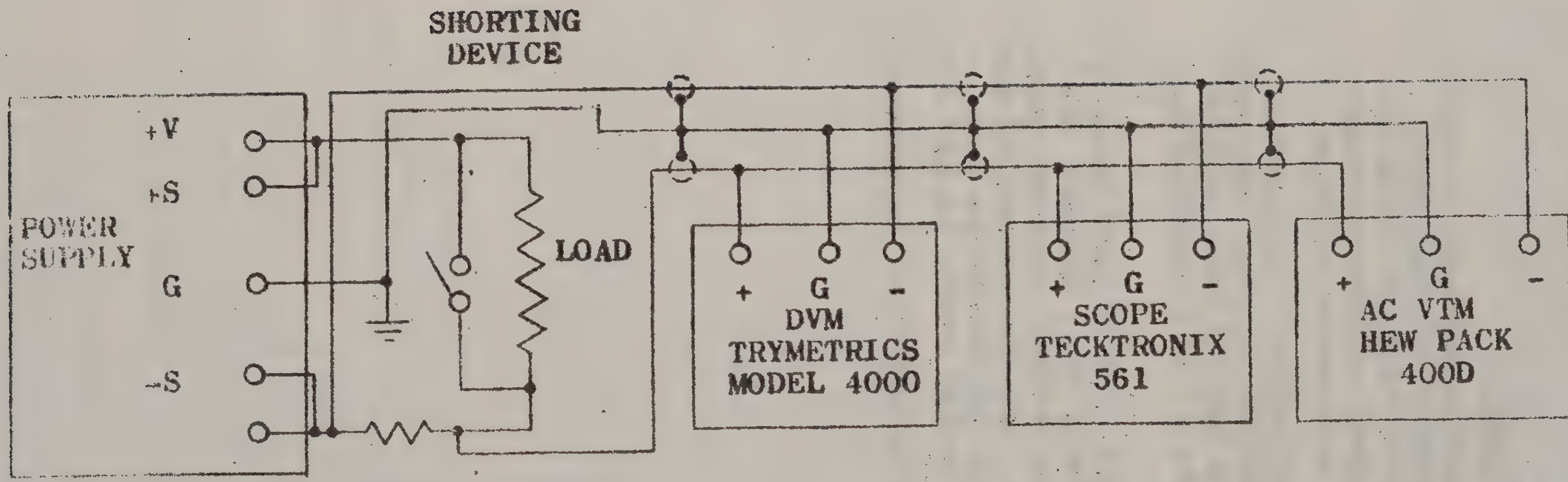


FIGURE 5-2
CONSTANT CURRENT OPERATION

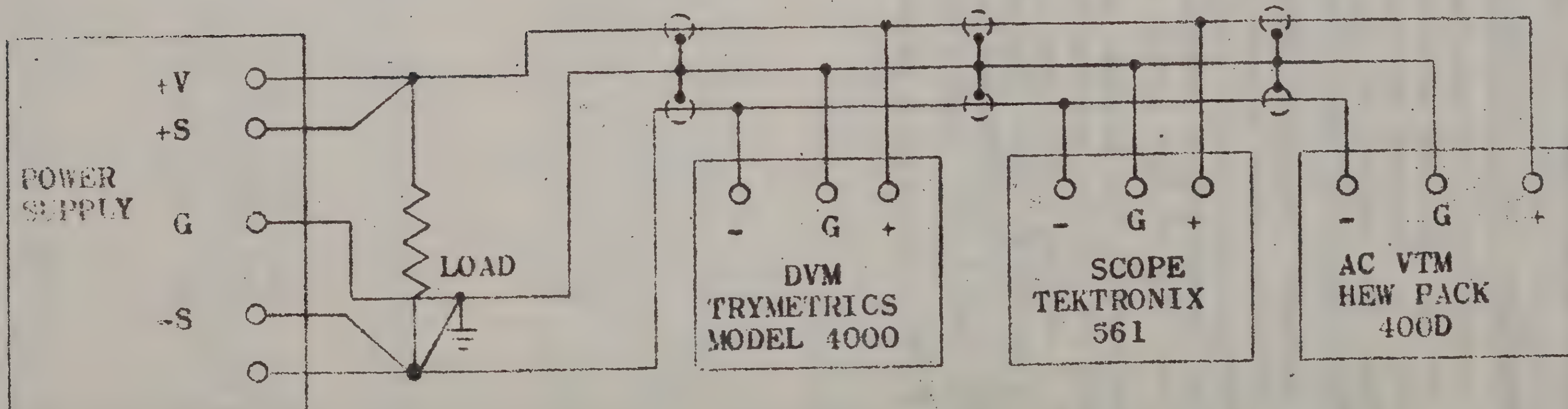


FIGURE 5-1
CONSTANT VOLTAGE OPERATION

SECTION 5

TROUBLESHOOTING

Set voltage adjust and voltage vernier controls fully CW. Using a 20,000 ohms per volt voltmeter or oscilloscope, check the voltages across the various components listed in the trouble-guide. The sample voltages listed in this guide apply only if the unit is operating at its nominal AC input, and has a dummy load of sufficient size connected across its output to allow operation at maximum rated current and voltage output levels. Any reading which is grossly incorrect indicates that the stage being tested or the one immediately preceding it, is defective. The Block Diagram, Schematic Diagram and appropriate sections of the Theory of Operation will prove helpful in any trouble-shooting work. Proper polarity to be observed when testing can be easily obtained from the Schematic Diagram.

If voltage checks show no noticeable deviations from the prescribed values, disconnect AC power and proceed with point to point resistance checks across pots, switches, diodes, resistors, transistors in that order.

When the trouble is of an intermittent nature such as poor regulation, ripple, etc., the use of an oscilloscope to determine dynamic changes will be necessary.

The section on Theory of Operation should be consulted to determine circuit performance with varying output conditions.

All voltages ± 10%	M7C5-130	M5C15-50 M7C8-100 M7C15-30	M5C40-30 M7C40-50	M5C60-15 M7C60-30	M5C160-5 M7C160-8 M7C160-16
		PRE-REG. CIRCUITRY			
C106+R125	3.V	3. to 4.V	5. to 6.V	8. to 9.V	12. to 15.V
C101	30.0	30.0	30.0	30.0	30.0
CR108	24.0	24.0	24.0	24.0	24.0
R113	6.8	6.8	6.8	6.8	6.8
R119	4.8	4.8	4.8	4.8	4.8
R114	4.2	4.2	4.2	4.2	4.2

TROUBLE SHOOTING GUIDE

Component	M7C8-100	M7C15-80	M7C40-50	M7C60-30	M7C160-8	M7C160-15	M5C15-50	M5C40-30	M5C60-15	M5C160-5	M3P8-250V	M5P8-500v	M5P15-30	M5P36-15	M5P60-10	
Ref. Supply																
C1	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	Input filter capacitor
C2	15.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---→	output " "
R3	9.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---→	Voltage divider
R13	1.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---→	Input limiting resistor
R6F	5.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---→	Q2 emitter "
CR12	9.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---→	Reference zener
Amplifier ckt																
R4	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---→	Voltage divider
R26	5	---	---	---	---	---	---	---	---	---	---	---	---	---	---→	" "
CR3,30	0	---	---	---	---	---	---	---	---	---	---	---	---	---	---→	Protection diodese for A2 input
CR14	15	---	---	---	---	---	---	---	---	---	---	---	---	---	---→	Negative voltage source
CR15	15	20	50	70	180	180	20	40	70	180	10	10	18	39	68	Output clamping zener
Current limiting ckt																
CR13	9.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---→	Zener reference
R6D	5	---	---	---	---	---	---	---	---	---	---	---	---	---	---→	Biasing resistor for Q4
R12	9.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---→	Voltage divider
R9+24	9.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---→	" "

Semi-conductors commonly used in Trygon power supplies are available for replacement or spare parts use under the following Trygon, commercial manufacturer or JEDEC part number

TRANSISTORS

S E M I - C O N D U C T O R P A R T N U M B E R S

TRYGON STOCK NO.	TRYGON or MFR P/N	JEDEC EQUIVALENT
700000	See 705067	
700001	See 700002	
700002	700002	2N3638A
700010	TR346	2N1556
700020	See 705067	
700030	TR361	2N652
700040	TR375	2N1533
700047	700047	2N4238
700050	700050	2N657A
700070	TR951	2N2527
700080	700080	2N3055
700083	700083	2N3232
700085	700085	2N3442
700115	See 705067	
700120	700120	2N1530
700130	700130	2N1554
700140	700140	2N1560
700160	700160	2N2140
700180	700180	2N2714
700182	700182	2N3566
700191	700191	2N4912
700195	700195	2N3441
700196	700196	2N4912
700197	700197	2N3738
700200	700200	2N2139
700205	700205	2N3440
700400	700400	2N3441
700401	700401	2N3771
700402	700402	2N3772
700410	700410	2N3442
700412	700412	2N3568
700413	700413	2N3644
700415	700415	2N3585
700417	700417	2N4918
700420	700420	2N3584
700429	DTS411	DTS411
700430	DTS413	DTS413
700431	DTS423	DTS423
700502	700502	2N5037
700508	700508	2N5240
705018	705018	2N3416
705067	705067	2N2905A
705068	705068	2N2219A
705069	705069	2N4340
705070	705070	2N3233
705071	705071	2N3447
720145	UJ25	2N2647

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RECTIFIERS

SEMI-CONDUCTORPARTNUMBERS

TRYGON STOCK NO.	TRYGON or MFR P/N	JEDEC EQUILVALENT
705014	705014	2N1929
720000	C35B	2N685
720005	C33F	
720010	C35F	2N682
720015	C30F	
720030	C50AX258	
720040	C50B	2N1913
720043	C50C	2N1915
720050	C50F	2N1910
720053	C60A	2N2025
720060	E016	
720075	E0130	
720110	SV515	1N823
720131	720131	1N3618
720132	720132	1N3616
720133	720133	1N3619
720135	720135	1N3495R
720136	720136	1N3621
720137	720137	1N3622
720173	1N759A	1N5242B
720175	1N746A	1N5226B
720181	1N751A	1N5231B
720182	1N754A	1N5235B
720185	1N752A	1N5232B
720192	1N753A	1N5234B
720196	1N755A	1N5236B
720241	1N1360A	1N2986A
720262	1N2163A	1N2163A
720263	1N2163A	1N2163A
720273	SCR285-2	
720274	SCR285-3	
720275	SCR285-4	
720277	SCR285-5	
720280	SCR93-2	
720290	SCR93-3	2N2573
720300	SCR93-4	2N2574
720301	SCR93-5	2N2677
720303	SCR93-7	
720330	70H10	
720335	40HF10	1N1184A
720350	70H20	1N4136
720383	1N4585	1N4585
720384	1N4384	1N4384
720387	1N4740A	1N4740A
720388	1N4733A	1N4733A
720394	1N964B	1N5243B
720395	1N965B	1N5245B

Semi-conductors commonly used in Trygon power supplies are available for replacement of spare parts use under the following Trygon, commercial manufacturer or JEDEC part number

RECTIFIERS

SEMI-CONDUCTOR PART NUMBERS

TRYGON STOCK NO.	TRYGON or MFR P/N	JEDEC EQUILVALENT
720427	See 720136	
720440	TR4148	1N4148
720443		1N3208
720450	See 720456	1N3659
720453	See 720456	1N4719
720454	MR1031A	1N4720
720455	MR1032A	1N4721
720456	MR1034A	1N4722
720458	See 720456	
720459	1N758	1N758
720397	1N2164A	1N2164A
720460	1N961B	1N5240B
720468	1N968	1N5250B
720473	1N821	1N821
720488	60HF60	1N2138
720489	C46E	
725008	C180A	
725019	1N765A	1N5241B
725056	MR1220SL	
725071	1N3515A	1N5236B
725076	1N3616	1N3616
725077		1N3262R
725079	MCR2835-4	
725081	MCR216R-2	
725082	MCR216R-3	
725083	MCR216R-5	
725085	MCR216R-6	
725087	MCR3918-1	2N5168
725138	725138	2N4441
725139	See 725142	
725140	MAC 3-2	
725142	725142	2N4442
725143	Y0525	
725144	40526	
741001	741001	2N4990

MODEL M7C8-100

LIST OF ELECTRICAL PARTS

Designation	Component	MFR	Part Number	Spares	TRYGON STOCK =
B1	BOXER FAN	ROT.	VENTURI	1	890020
C1	CAP. 450MF, 50V	SPRA	39D457G050FP4	1	810212
C2,3	CAP. 15MF, 20V	FAIR	TS2K-20-156M	2	821020
C4	CAP. 10MF, 50V	MALL	TYPE TTXE	1	810010
C6	CAP. .022MF, 200V	SPRA	192P22392	1	800110
C7	CAP. .0001MF, 1KV	C-D	LA10T1-S3	1	800000
C8,20	CAP. 6.8MF, 35V	DEL	CS13BF685K	2	821021
C11	CAP. 31000MF, 15V	TRY	820402	1	820402
C12,13,15	CAP. 9000MF, 20V	TRY	820471	3	820471
C16,17	CAP. .01MF, 600V	A-C	GP103P	2	800090
C18,19	CAP. .15MF, 250V	I.E.	CM1500-2	2	800210
C21,302	CAP. .22MF, 250V	I.E.	CM2200-2	2	800252
C22	CAP. .0068MF, 600V	ERIE	CKAW682M	1	800055
C25	CAP. 68MF, 50V	G.E.	76F02LN680	1	810080
C27	CAP. .0033MF, 600V	ERIE	CK62AW332M	1	800025
C60,61,104	CAP. 250MF, 6V	SPRA	40D257F006DH4	3	810170
C100	CAP. 20MF, 50V	SPRA	40D206F050DC2	1	810021
C101	CAP. 100MF, 50V	SPRA	600D107G353DJ4	1	810132
C102,107,110	CAP. 1MF, 200V	TRW	X663F	3	800182
C103	CAP. .47MF, 200V	TRW	X663F	1	800269
C105	CAP. .047MF, 400V	I.E.	MET MYLAR	1	800155
C106	CAP. 450MF, 20V	SANG	556EJ421W020B	1	810209
C300	CAP. 950MF, 50V	SANG	500-1154-03	1	820050
C303	CAP. 1MF, 250V	I.E.	CM10000-2	1	800304
CB1	CIRCUIT BREAKER	HEIN	AM12-50	1	760181
CR1,2,3,4,5,18, 19,30,38,100, 101,102,103, 104,109,110, 111,115,117, 118	DIODE ZENER	G.I.	1N4384	20	720384
CR6,7,8,9,11	DIODE	TRY	TR4148	5	720440
CR10	UNILATERAL SWITCH	G.E.	2N4990	1	741001

MODEL M7C8-100

LIST OF ELECTRICAL PARTS

Designation	Component	MFR	Part Number	Spares	TRYGON STOCK #
CR12,13	DIODE	TRY	720262	2	720262
CR14,15	DIODE	UNIT	UZ715	2	720150
CR16,301	DIODE	MOTO	MR1031A	2	720454
CR21,22	SCR	G.E.	C60A	2	720053
CR23	RECTIFIER	TRY	720123	1	720123
CR24,25,27	DIODE	IRC	70H10	3	720330
CR26	DIODE	IRC	70H20	1	720350
CR29	DIODE ZENER	TRAN	1N751A	1	720181
CR106	DIODE	HOFF	1N1360A	1	720241
CR112	DIODE	UNIT	UZ724	1	720155
CR116	DIODE	TRAN	1N765	1	725019
R1	RLTC. 550Ω, 3W, 3%	SAGE	1300S550-3	1	630350
R2	RLTC. 450Ω, 3W, 3%	SAGE	1300S450-3	1	630325
R3	RLTC. 800Ω, 3W, 3%	SAGE	1300S800-3	1	630380
R4	RLTC. 300Ω, 3W, 3%	SAGE	1300S300-3	1	630284
R6	RESISTOR NETWORK	TRY	740020	1	740020
R9	RLTC. 8KΩ, 3W, 3%	SAGE	1300S8000-3	1	630510
R10	RMF. 402Ω, .5W, 1%	IRC	TYPE CECTO	1	620140
R11	RMF. 3.57KΩ, .5W, 1%	IRC	TYPE CECTO	1	620481
R12	RMF. 51KΩ, .5W, 2%	IRC	TYPE RG20	1	620720
R13	RCOMP. 22Ω, .5W, 10%	A-B	RC20GF220K	1	610012
R14,15	RCOMP. 330Ω, .5W, 10%	A-B	RC20GF331K	2	610120
R16	RCOMP. 470Ω, .5W, 10%	A-B	RC20GF471K	1	610140
R17	RMF. 1.5KΩ, .5W, 1%	IRC	TYPE CECTO	1	620360
R18,19	RCOMP. 560Ω, .5W, 10%	A-B	RC20GF561K	2	610150
R20	RCOMP. 22KΩ, .5W, 10%	A-B	RC20GF220K	1	610310
R21	RWW. 470Ω, 2W, 10%	IRC	TYPE BWH	1	640440
R22	POT. 200Ω	IRC	TYPE 100	1	600101
R23	POT. 150Ω, 1.5W	TRY	600071	1	600071
R24	POT. 2KΩ	IRC	TYPE 100	1	600226
R25	POT	TRY	600021	1	600021
R26	RLTC. 500Ω, 3W, 3%	SAGE	1300S500-3	1	630340
R39	POT. 1KΩ, 4W	TRY	600170	1	600170

MODEL M7C8-100

LIST OF ELECTRICAL PARTS

Designation	Component	MFR	Part Number	Spares	TRYGON STOCK =
R40	POT. 50Ω, 2W	TRY	600030	1	600030
R41	POT. 500Ω, 2W	TRY	600140	1	600140
R42	POT. 350Ω, 2W	TRY	600110	1	600110
R44	SHUNT	TRY	094340	1	094340
R45	RCOMP. 3.3KΩ, .5W, 10%	A-B	RC20GF332K	1	610230
R46,109	RCOMP. 1KΩ, .5W, 10%	A-B	RC20GF102K	2	610180
R47	RWW. 50Ω, 10W	W-L	TYPE 10XM	1	640300
R48	RWW. 100Ω, 25W	IRC	TYPE 2D	1	650520
R49	RCOMP. 150KΩ, .5W, 10%	A-B	RC20GF154K	1	610360
R53	POT. 10Ω, 2W	TRY	600010	1	600010
R54,55,56,57,58 59,60,61,62,63	RWW. .03Ω, 5W, 5%	SAGE	1500S.03-5	10	640025
R66	RWW. 20Ω, 50W	CLARO	VP50KA	1	650374
R72,107,108	RCOMP. 33Ω, .5W, 10%	A-B	RC20GF330K	3	610020
R74,76	RCOMP. 3.3KΩ, .5W, 10%	A-B	RC20GF332K	2	610230
R78	RMF. 15KΩ, .5W, 1%	IRC	TYPE CECTO	1	620627
R80	RMF. 698Ω, .5W, 1%	IRC	TYPE CECTO	1	620233
R81,89	RCOMP. 220Ω, .5W, 10%	A-B	RC20GF221K	2	610100
R85	RCOMP. 100Ω, .5W, 10%	A-B	RC20GF101K	1	610070
R100	RWW. 1KΩ, 5W, 5%	W-L	5XM1000	1	640510
R101	RLTC. 750Ω, 3W, 3%	SAGE	1300S750-3	1	630375
R102	RLTC. 100Ω, 3W, 3%	SAGE	1300S100-3	1	630260
R103	RWW. 500Ω, 5W	W-L	5XM500	1	640460
R104,106	RCOMP. 470Ω, .5W, 10%	A-B	RC20GF471K	2	610140
R105	RCOMP. 2.2KΩ, .5W, 10%	A-B	RC20GF222K	1	610210
R110	RCOMP. 680Ω, .5W, 10%	A-B	RC20GF681K	1	610160
R112,130	RMF. 9.95KΩ, .5W, 1%	IRC	TYPE CECTO	2	620600
R113	RMF. 3.95KΩ, .5W, 1%	IRC	TYPE CECTO	1	620510
R114	RMF. 3.01KΩ, .5W, 1%	IRC	TYPE CECTO	1	620480
R115	RMF. 22.1KΩ, .5W, 1%	IRC	TYPE CECTO	1	620675
R117	RMF. 1.92KΩ, .5W, 1%	IRC	TYPE CECTO	1	620390
R118	RMF. 19.9KΩ, .5W, 1%	IRC	TYPE CECTO	1	620660
R119	RMF. 4.99KΩ, .5W, 1%	IRC	TYPE CECTO	1	620580

MODEL M7C8-100

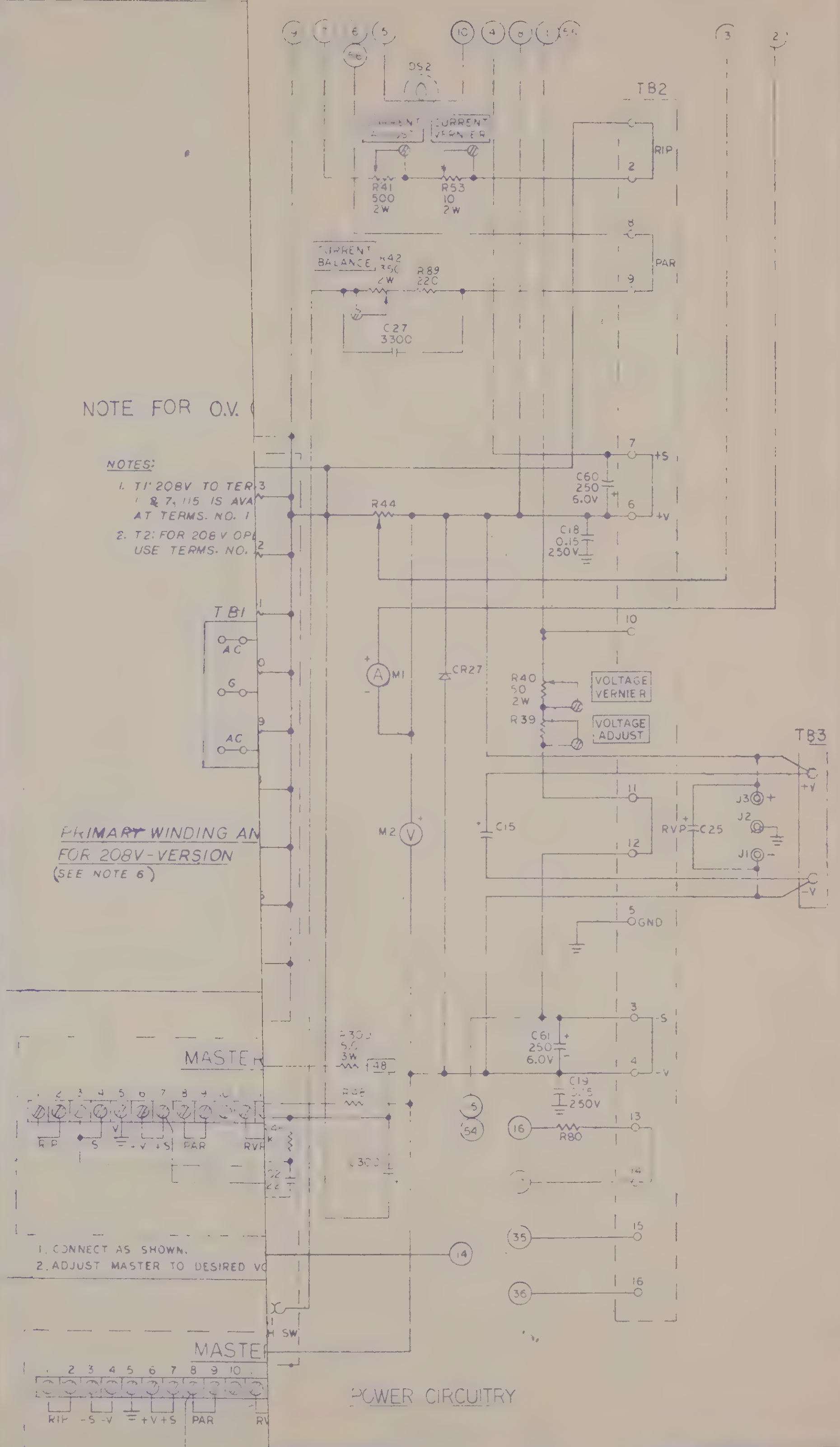
LIST OF ELECTRICAL PARTS

Designation	Component	MFR	Part Number	Spares	TRYGON STOCK #
R121	POT. 10KΩ, 1.5W	CTS	TYPE 110	1	600348
R122	RCOMP. 100KΩ, .5W, 10%	A-B	RC20GF104K	1	610350
R123,132	RCOMP. 150KΩ, .5W, 10%	A-B	RC20GF154K	2	610360
R124	RMF. 130KΩ, .5W, 1%	IRC	TYPE CECTO	1	620810
R125	RLTC. 10KΩ, 3W, 3%	SAGE	1300S10000-3	1	630520
R126	RCOMP. 47Ω, .5W, 10%	A-B	RC20GF470K	1	610030
R128	RMF. 19.95KΩ, .5W, 1%	IRC	TYPE CECTO	1	620650
R131	RMF. 39.95KΩ, .5W, 1%	IRC	TYPE CECTO	1	620700
R133	POT. 50KΩ, .5W	ELECT.	ET34X503	1	600417
R134,135	RCOMP. 1.2KΩ, .5W, 10%	A-B	RC20GF122K	2	610190
R300	RLTC. 5Ω, 3W, 3%	SAGE	1300S5-3	1	630110
Q1	TRANSISTOR	TRAN	TR1132	1	700000
Q2	TRANSISTOR	FAIR	2N3566	1	700181
Q3,4,100,103, 104,105,106	TRANSISTOR	FAIR	2N3638A	7	700001
Q5	TRANSISTOR	TRY	700071	1	700071
Q13	TRANSISTOR	MOTO	2N4238	1	700047
Q14	TRANSISTOR	TRY	700196	1	700196
Q15,21,22,23, 24,25,26,27, 28,29,30	TRANSISTOR	TRY	700401	11	700401
Q101	TRANSISTOR	RCA	TR1591	1	700191
Q102	UNIJUNCTION	G.E.	UJ25	1	720145
DS1	PILOT LIGHT	FERI	5SRHF2R1N1SL	1	770020
DS2	LIGHT INDICATOR	I.D.	2090-A87	1	770023
A1,2	INTERGRATED CIRCUIT	TRY	740005	2	740005
L1,2	CHOKE	ARNOLD	A254168-2	2	503170
L3	CHOKE	TRY	501570	1	501570
M1	METER 100A. Ext.	AMMON	TYPE AP-2	1	750104
M2	METER 10V	AMMON	TYPE AP-2	1	752016
S1	THERMAL SWITCH	TRY	880007	1	880007
T1	TRANSFORMER (MAIN)	TRY	501550	1	501550
T2	TRANSFORMER (AUX)	TRY	501560	1	501560

LIST OF ELECTRICAL PARTS -

Designation	Component	MFR	Part Number	Spares	TRYGON STOCK #
CR200,201	DIODE	TRAN	1N751A	2	720181
CR202,203,204, 209	DIODE	G.I.	1N4384	4	720384
CR205	TRIAC	RCA	40525	1	725143
CR206	DIODE	TRY	725086	1	725086
CR207	SCR	TRY	720044	1	720044
CR208	DIODE	MOTO	1N753A	1	720192
R200	RCOMP. 330Ω, .5W, 10%	A-B	RC20GF331K	1	610120
R201	RCOMP. 22KΩ, .5W, 10%	A-B	RC20GF223K	1	610310
R202	RMF. 49.95KΩ, .5W, 10%	IRC	TYPE CECTO	1	620723
R203	RMF. 511Ω, .5W, 1%	IRC	TYPE CECTO	1	620180
R204, 213	RCOMP. 10KΩ, .5W, 10%	A-B	RC20GF103K	1	610290
R205,207,208	RCOMP. 2.2KΩ, .5W, 10%	A-B	RC20GF222K	3	610210
R206,218	RCOMP. 1.5KΩ, .5W, 10%	A-B	RC20GF152K	2	610195
R209	RCOMP. 100Ω, .5W, 10%	A-B	RC20GF101K	1	610070
R210	RMF. 5.11KΩ, .5W, 1%	IRC	TYPE CECTO	1	620589
R211	RMF. 1.5KΩ, .5W, 1%	IRC	TYPE CECTO	1	620360
R212	RCOMP. 10Ω, .5W, 10%	A-B	RC20GF100K	1	610006
R214	RCOMP. 1.2KΩ, .5W, 10%	A-B	RC20GF122K	1	610190
R215	POT. 2.5KΩ, 2W	TRY	600230	1	600230
R216	RCOMP. 1KΩ, .5W, 10%	A-B	RC20GF102K	1	610180
R217	BUSS BAR	TRY	097460	1	097460
R219	RCOMP. 12KΩ, .5W, 10%	A-B	RC20GF123K	1	610295
Q200,203	TRANSISTOR	FAIR	2N3638A	2	700001
Q201,202	TRANSISTOR	FAIR	2N3566	2	700181

MASTER		
M7C15-80	M7T15-80	M7C15-80
M7C8-100 OV	M7T8-100	M7C8-100
M7C40-50	M7T40-50	M7C40-50
M7C60-30	M7T60-30	M7C60 30



UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES ± 1/64 ± .005 ± 1/2°

DRAWING STARTED | DATE

SYSTRON DONNER CORPORATION WESTBURY TRYGON NEW YORK

MODEL M7C SERIES

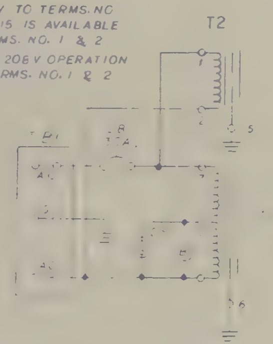
SCHEMATIC DIAGRAM

SIZE E CODE IDENT NO 09206

[illegible]		L5	C15	C12,13	CR23	CR21,22	M1 (A)	M2 (V)	R39	R44	R48	L1,L2	R66	R54-R63	Q21-30	Q15	CR27	CR16 CR301	C300	R47	R80	C25	Q14	C303	R79	R80	C304
M7C15-80	M7T15-80	M7C15-80	90,000 20V	64,000 30V	720123	C60A	0-100	0-20	1.8K 4W	.0063	150 25W	M7L-15-80	50 50W	.05 5W	2N3771	2N3771	720330	MR1032A	950 50V	50 10W	SHORT	65 50V	700191	0.47 200V	SHORT	SHORT	0.1 100V
M7C8-100 OV	M7T8-100	M7C8-100	90,000 20V	90,000 20V	720123	C60A	0-100	0-10	1K 4W	.005	100 25W	M7L-8-100	20 50W	.03 5W	2N3771	2N3771	720330	MR1031A	950 50V	50 10W	SHORT	65 50V	700196	0.47 200V	SHORT	698, 1%	0.1 100V
[illegible]	M7T40-50	M7C40-50	34,800 50V	30,000 60V	70H15	C50B	0-50	0-40	5K 4W	.010	500 25W	M7L-40-50	100 50W	0.1 3W	2N3772	700080	70H10	[illegible]	290 150V	200 3W	SHORT	20 100V	700191	0.01 600V	4.7	SHORT	OMIT
[illegible]	[illegible]	M7C60-30	30,000 60V	11,600 100V	70H15	C50C	0-30	0-60	7.5K 4W	.017	1K 25W	M7L 60-30	200 50W	0.2 3W	2N3772	700080	70H10	MR1034A	160 250V	200 3W	15 25W	45 175V	700191	0.01 600V	4.7	SHORT	OMIT

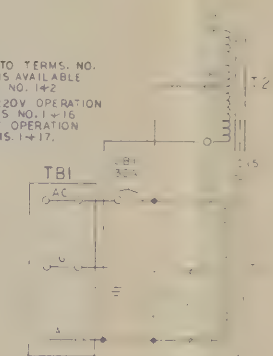
NOTE FOR O.V. CIRCUIT REFER TO DWG D-#9961

NOTES:
1. T1: 208V TO TERMS. NO & 7. 115 IS AVAILABLE AT TERMS. NO. 1 & 2
2. T2: FOR 208V OPERATION USE TERMS. NO. 1 & 2

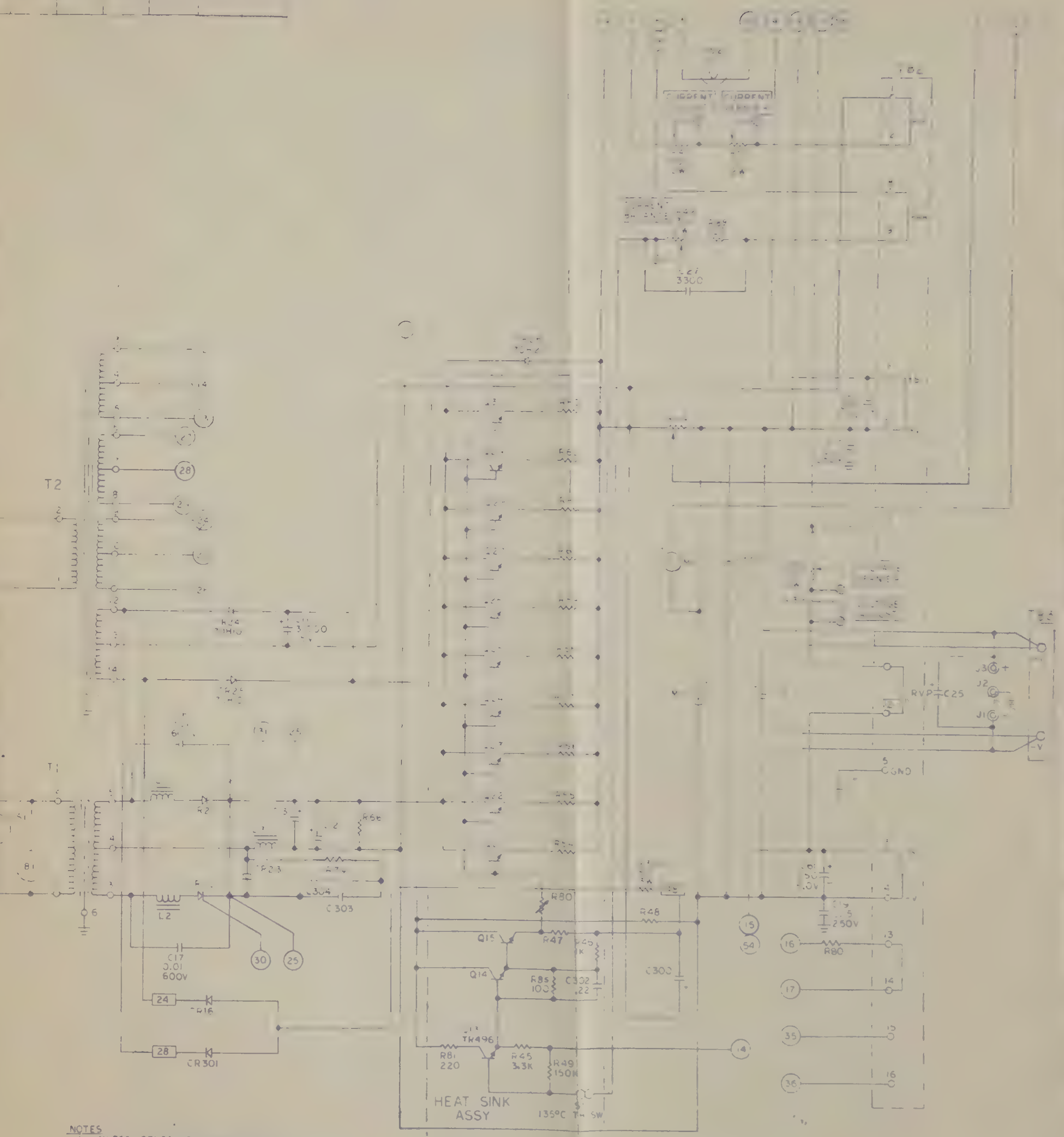


PRIMARY WINDING AND CONNECTIONS FOR 208V-VERSION
(SEE NOTE 6)

NOTES:
1. T1: 220V TO TERMS. NO. 1+10, 115 IS AVAILABLE AT TERMS. NO. 1+2
2. T2: FOR 220V OPERATION USE TERMS NO. 1 + 16 FOR 240V OPERATION USE TERMS. 1 + 17.

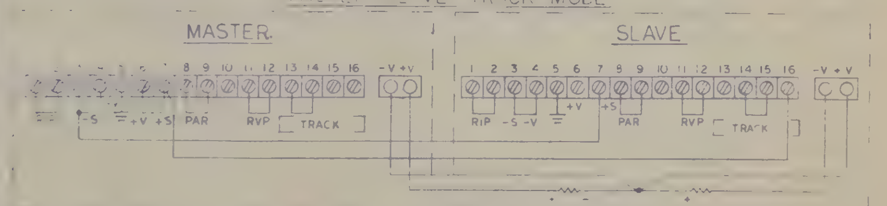


PRIMARY WINDING AND CONNECTIONS FOR E VERSION (220V APPLICATION)
(SEE NOTE 3.)



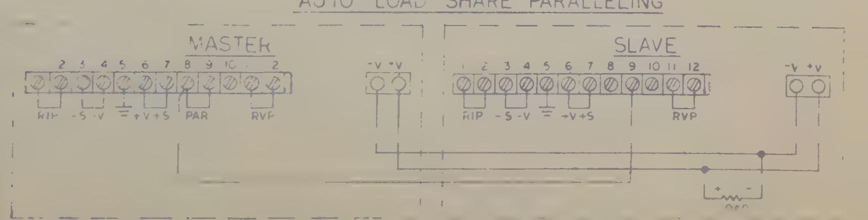
POWER CIRCUITRY

MASTER - SLAVE TRACK MODE



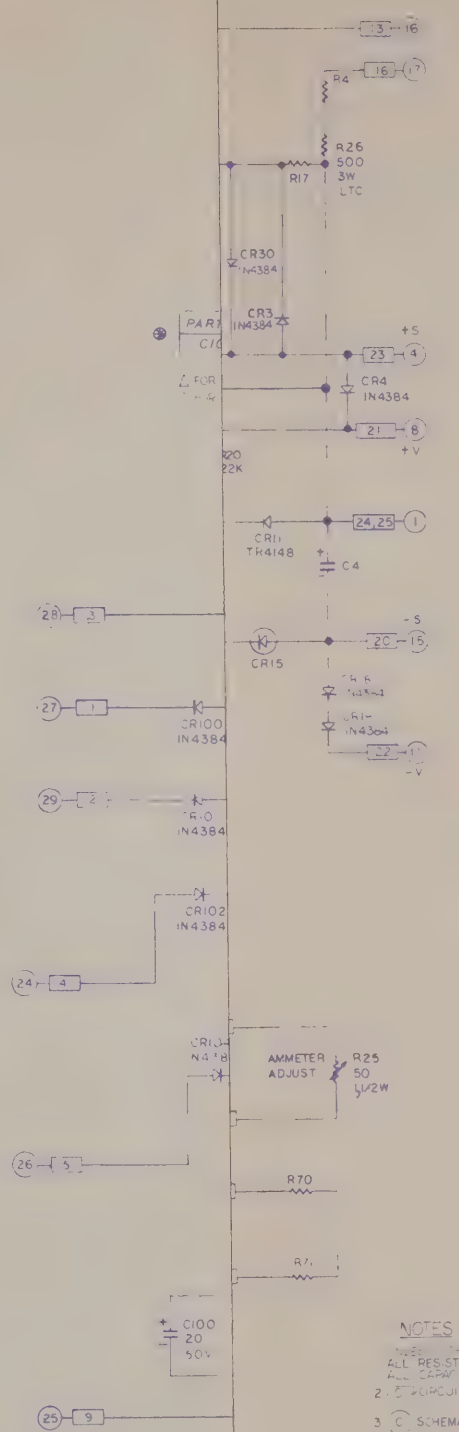
1. CONNECT AS SHOWN.
2. ADJUST MASTER TO DESIRED VOLTAGE.
3. SET SLAVE EQUAL TO MASTER.
4. UNITS WILL NOW TRACK.
5. MASTER CONTROLS VOLTAGE.

AUTO LOAD SHARE PARALLELING



1. CONNECT AS SHOWN.
2. APPLY MAXIMUM LOAD.
3. BALANCE CURRENT WITH "CURRENT BALANCE" CONTROL.
4. MASTER UNIT CONTROLS VOLTAGE.

NOTES
1. UNLESS OTHERWISE SPECIFIED. ALL RESISTORS ARE IN OHMS, 1/2 WATT 10% ALL CAPACITORS ARE IN MICROFARADS.
2. UNLESS OTHERWISE SPECIFIED USE ABOVE TABLE FOR VALUES
3. FOR UNITS WITH 220V TRANSFORMER ADD "E" TO APPLICABLE MODEL.
4. $\boxed{C}$ CIRCUIT BOARD PIN IDENTIFICATION.
5. (O) SCHEMATICS INTERCONNECTIONS.
6. FOR UNITS WITH 208V TRANSFORMER ADD "208V" TO APPLICABLE MODEL



NOTES

ALL RESISTORS ARE IN OHMS 1/2W 5%
ALL CAPACITORS ARE IN MICROFARADS
2. CIRCUIT BOARD PIN IDENTIFICATION
3. (C) SCHEMATIC INTERCONNECTIONS.
4. SELECT AT TEST
5. THESE RESISTORS SUPPLIED IN SINGLE IC
6. FOR X VERSION ONLY CR12 IS 1N2167

M7C60-30	UZ770	8, 100
M7C40-50	UZ750	8, 100
M7C8-1000V	UZ715	10, 50
M7C [illegible]	UZ720	10, 50
MODEL	CR15	C4

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ± ½°

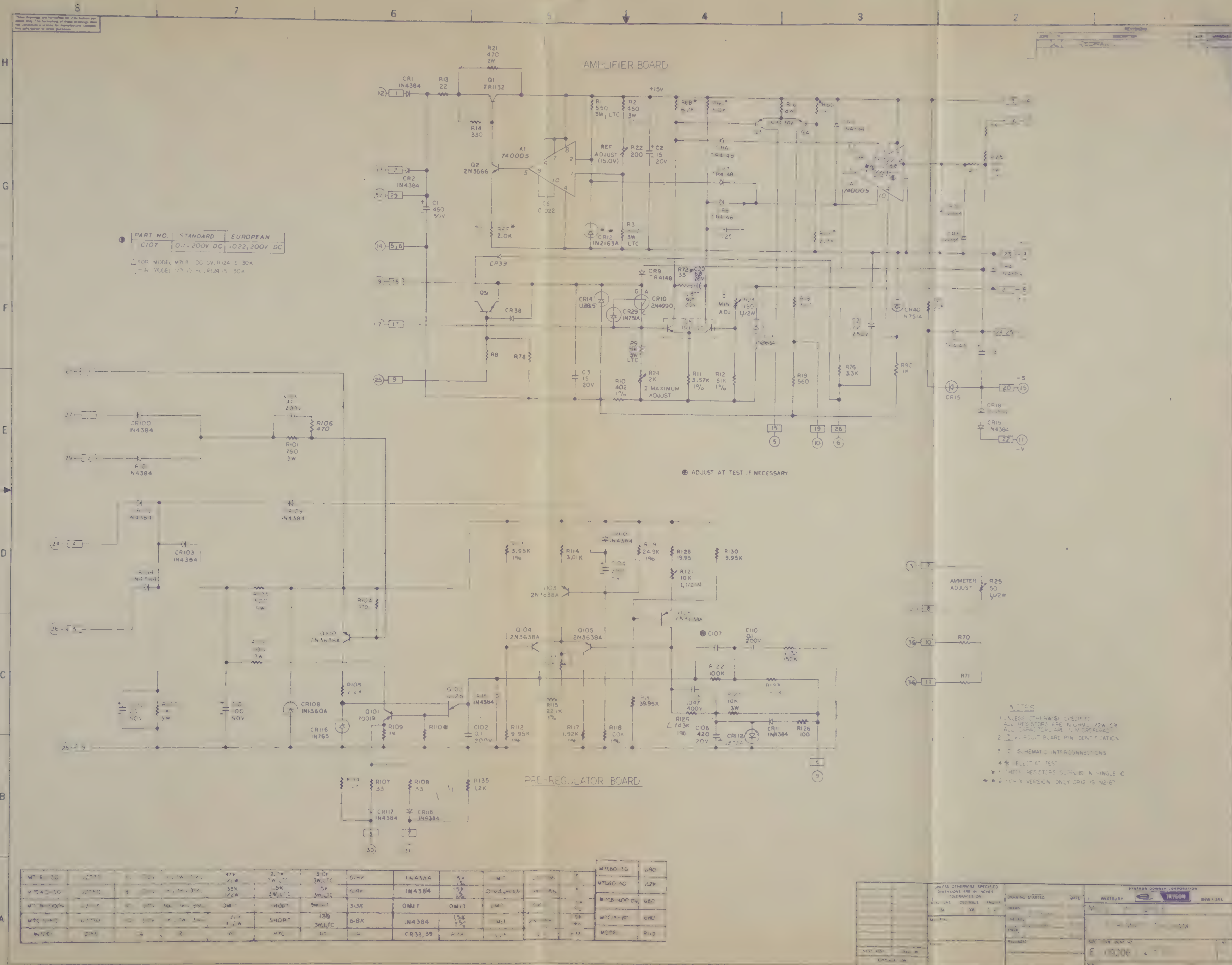
DRAWING STARTED DATE
DRAWN
CHECKED
ENGR.
RELEASED

SYSTRON DONNER CORPORATION
WESTBURY TRYGON NEW YORK

MODEL M7C SERIES

SCHEMATIC DIAGRAM

SIZE E CODE IDENT NO 09206



AMPLIFIER BOARD
PRE-REGULATOR BOARD
PART NO. | STANDARD | EUROPEAN
C107 | .01, 200V DC | .022, 200V DC
ADJUST AT TEST IF NECESSARY
REF ADJUST (15.0V)
I MAXIMUM ADJUST
AMMETER ADJUST
NOTES

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Send for SYSTRON DONNER
1972/1973 Instruments Catalog

Catalog C672

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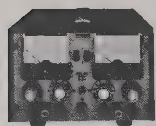
TRYGON DC POWER SUPPLIES

For Wide Range Laboratory & Systems Applications



$249.

DL Series Dual Lab

- Dual Outputs — Independently Adjustable
- Dual Ranges on Each Output
- 0.01% Regulation
- 250 uV RMS Ripple
- 0.05% Stability
- Calibrated Adjustable Current Limiting

DL Series:
Switchable dual range ammeter/voltmeter for each supply; selectable current limit ranges; 47-420 Hz input; 50°C operation.

Model	Volts	Amps	Panel Ht. (")
DL40-1	0-20	1	4-15/16
	0-40	0.5	4-15/16

$225.
$249. (OV)

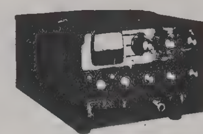
TL Series Triple Lab

- Triple Outputs — Independently Adjustable
- 0.02% Regulation
- 0.5 mV RMS Ripple
- 0.05% Stability
- Automatic Current Limiting
- Overvoltage Protection Option

TL Series:
Switchable ammeter/voltmeter for each supply; 57-420 Hz input; 40°C operation.

Model	Volts	Amps	Panel Ht. (")
TL8-3	0 to +8	3	4-7/8
OR	0 to +32	1	
TL8-3 OV	0 to - 32	1	

NEW FOR '72



$315.

PLS Series Precision Lab

- 5 Dial Calibrated Output, 0.1% Accuracy
- 0.001% Regulation
- 50 uV RMS Ripple
- 0.002% Stability
- Fast Programming
- Adjustable Current Limiting
- Current Sink Capability
- Panel Overload Indicator

PLS Series:
47-420 Hz input; Multi-Versatile Remote Programming: Ohms/Volt, Volt/Volt, Analog Voltage, Current Limiting; Programming Compatible with Trygon Digital Programmer for Computer Applications; Overvoltage Protection Option.

Model	Volts	Amps	Panel Ht. (")
PLS50-1	0-50	0-1	4-7/8

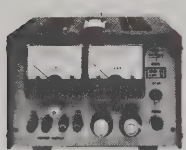
Priced from $175. to $225.

HH Series Quarter Rack

- Constant Voltage/Current
- 0.01% Regulation
- 0.5 mV RMS Ripple
- 0.05% Stability (0.01% Optional)

HH Series:
CV/CC Mode Light; 47-420 Hz input; 60°C operation; Overvoltage Protection option; High Stability option.

Model	Volts	Amps	Panel Ht. (")
HH7-4 OV	0-7	4	5
HH15-3	0-15	3	5
HH32-1.5	0-32	1.5	5
HH50-1	0-50	1	5
HH160-300	0-160	0.3	5



Priced from $325. to $540.

HR Series Half Rack

- Constant Voltage/Current
- 0.01% Regulation
- 0.5 mV RMS Ripple
- 0.05% Stability (0.01% Optional)
- Adjustable Current Limiting

HR Series:
CV/CC Mode Light; 55-65 Hz input; 60°C operation; Overvoltage Protection option.

Model	Volts	Amps	Panel Ht. (")
HR20-10B	0-20	10	4-7/8
HR40-5B	0-40	5	4-7/8
HR40-7.5B	0-40	7.5	4-7/8
HR60-2.5B	0-60	2.5	4-7/8
HR60-5B	0-60	5	4-7/8
HR160-2B	0-160	2	4-7/8

Priced from $425. to $645.

RS Series Low Profile

- Constant Voltage/Current
- 0.01% Regulation
- 0.5 mV RMS Ripple
- 0.05% Stability (0.01% Optional)

RS Series:
CV/CC Mode Light; 55-65 Hz input; 71°C operation; Overvoltage Protection option; High Stability option.

Model	Volts	Amps	Panel Ht. (")
RS20-15A	0-20	15	3-1/2
RS40-10A	0-40	10	3-1/2
RS60-7.5A	0-60	7.5	3-1/2
RS160-1A	0-160	1	3-1/2
RS160-3A	0-160	3	3-1/2
RS320-1.5B	0-320	1.5	3-1/2

$1195.

CR Series Intermediate Regulation

- Constant Voltage/Current
- 0.2% Regulation
- 150 mV RMS Ripple
- 0.25% Stability

CR Series:
CV/CC Mode Light; 208 VAC, 55-65 Hz 3-phase input; 50°C operation; Overvoltage Protection option.

Model	Volts	Amps	Panel Ht. (")
CR20-150	0-20	150	12-1/4
CR36-100	0-36	100	12-1/4
CR65-55	0-65	55	12-1/4
CR110-30	0-110	30	12-1/4

Priced from $445. to $1645.

M-C/M-P Series Super Mercury

- Constant Voltage/Current
- 0.005% Regulation
- 1 mV RMS Ripple
- 0.015% Stability (0.005% Optional)
- Adjustable Current Limiting
- Automatic Load Share Paralleling
- Master Slave Tracking

M-C/M-P Series:
CV/CC Mode Light; 47-65 Hz input; Overvoltage Protection option.

Model	Volts	Amps	Panel Ht. (")
M7C5-130 OV	0-5	130	7
M3P8-25 OV	0-8	25	3½
M5P8-50 OV	0-8	50	5¼
M7C8-100 OV	0-8	100	7
M5P15-30 OV	0-15	30	5¼
M5C15-50 OV	0-15	50	5¼
M7C15-80 OV	0-15	80	7
M5P36-15 OV	0-36	15	5¼
M5C40-30 OV	0-40	30	5¼
M7C40-50 OV	0-40	50	7
M5P60-10 OV	0-60	10	5¼
M5C60-15 OV	0-60	15	5¼
M7C60-30 OV	0-60	30	7
M5C160-5	0-160	5	5¼
M7C160-8	0-160	8	7
M7C160-15	0-160	15	7

TRYGON ELECTRONICS
SUBSIDIARY
SYSTRON DONNER
CORPORATION
1200 Shames Drive, Westbury, N.Y. 11590 (516) 997-6200

POWER SUPPLY SELECTOR & PRICE LIST

Wide Range Laboratory & Systems Applications

Voltage Range VDC	Max. Current Amps	Size	Price Metered $	OV Option $	Model** (See page 2)
0 to 5	130	7" Rack	895	STD	M7C5-130 OV
0 to 7	4	¼ Rack*	199	STD	HH7-4 OV
0 to 8	3				
0 to +32	1	½ Rack	225	24	TL8-3 (3 output)
0 to −32	1				
0 to 8	25	3½" Rack	445	STD	M3P8-25 OV
0 to 8	50	5¼" Rack	595	STD	M5P8-50 OV
0 to 8	100	7" Rack	895	STD	M7C8-100 OV
0 to 15	3	¼ Rack	180	45	HH15-3
0 to 15	30	5¼" Rack	545	STD	M5P15-30 OV
0 to 15	50	5¼" Rack	750	STD	M5C15-50 OV
0 to 15	80	7" Rack	1325	STD	M7C15-80 OV
0 to 20	10	½ Rack	365	65	HR20-10B
0 to 20	15	3½" Rack	435	65	RS20-15A
0 to 20	150	12¼" Rack	1195	175	CR20-150
0 to 32	1.5	¼ Rack	175	45	HH32-1.5
0 to 36	15	5¼" Rack	545	STD	M5P36-15 OV
0 to 36	100	12¼" Rack	1195	175	CR36-100
2X0 to 40	1	½ Rack	249	–	DL40-1 (2 output)
0 to 40	5	½ Rack	325	65	HR40-5B
0 to 40	7.5	½ Rack	419	65	HR40-7.5B
0 to 40	10	3½" Rack	425	65	RS40-10A
0 to 40	30	5¼" Rack	665	STD	M5C40-30 OV
0 to 40	50	7" Rack	850	STD	M7C40-50 OV
0 to 50	1	½ Rack	315	–	PLS50-1
0 to 50	1	¼ Rack	199	45	HH50-1
0 to 60	2.5	½ Rack	379	65	HR60-2.5B
0 to 60	5	½ Rack	399	65	HR60-5B
0 to 60	7.5	3½" Rack	495	65	RS60-7.5A
0 to 60	10	5¼" Rack	645	STD	M5P60-10 OV
0 to 60	15	5¼" Rack	665	STD	M5C60-15 OV
0 to 60	30	7" Rack	1135	STD	M7C60-30 OV
0 to 65	55	12¼" Rack	1195	175	CR65-55
0 to 110	30	12¼" Rack	1195	–	CR110-30
0 to 160	0.3	¼ Rack	225	–	HH160-300
0 to 160	1	3½" Rack	495	65	RS160-1A
0 to 160	2	½ Rack	540	90	HR160-2B
0 to 160	3	3½" Rack	645	90	RS160-3A
0 to 160	5	5¼" Rack	895	120	M5C160-5
0 to 160	8	7" Rack	1325	130	M7C160-8
0 to 160	15	7" Rack	1645	150	M7C160-15
0 to 320	1.5	3½" Rack	605	–	RS320-1.5B

*All ½ Racks and ¼ Racks mount in 5¼" panel height. Rack adapters available.

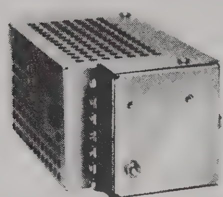
**Detailed Specifications for these units available on request.

TRYGON DC POWER SUPPLIES

For Slot Range Systems Applications

- Low Noise for IC Applications
- No Turn On/Turn Off Transients
- Extremely Low Output Impedance
- Compact Size — Modular & Metered Models
- Complete Series of ModuPanel Rack Adapters
- Wide Slot Adjustment Units
- Full Range Units
- UL Listed or Designed

A Size Package

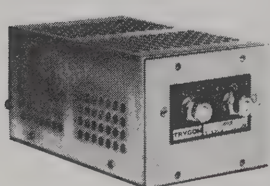


Priced from $35. to $88.

3″ x 3⁹⁄₁₆″ x 6″
TPSA

TP-A Super Trypack

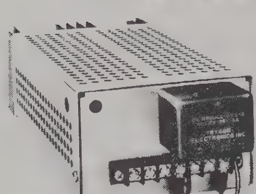
B Size Package



Priced from $85. to $131.

3⅛″ x 4″ x 6½″
LVS
LVW

C Size Package



Priced from $104. to $118.

3″ x 4⅝″ x 9″
TPSC
TPWC
TPZC
(with OVS)

TP-C Super Trypack

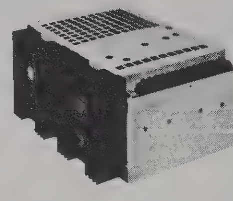
D Size Package

Priced from $63. to $144.

5″ x 4⅝″ x 9½″
TPZD
(with OVS)

TP-D Super Trypack

E & G Size Package



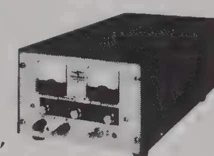
Priced from $163. to $330.

5″ x 8″ x 10″
TPWE
TPZE
TP3E
TP2E
5″ x 8″ x 15″
TP3G

TP-E, TP-G Super Trypack

Half Rack Package

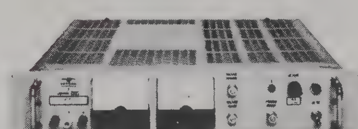
Priced from $314. to $418.



5¼″ x 7¾″ x 16¼″
LHS

Liberator Sub Rack
LHS (metered option)

Full Rack Package



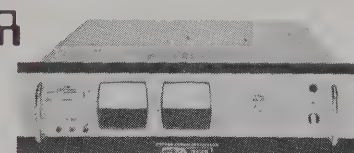
3½″ x 19″ x 18⅛″
L3R
5¼″ x 19″ x 18⅛″
L5R

Priced from $458. to $630.

L-R Series Liberator

NEW FOR '72

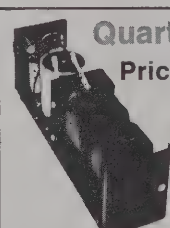
Full Rack Package



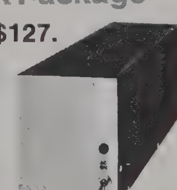
5¼″ x 19″ x 18⅛″ **$595.**

VP Series ValuPower

Quarter Rack Package



Priced from $127. to $190.



3⅞″ x 5″ x 15¾″ (uncased)
4¼″ x 5″ x 15¾″ (cased)

FT Series Ferroresonant

Systems Power in Every Package Size!

Other Features and Options

TPS Series: Systems Modules. Two package sizes; dual output versions available; UL Listed; .02% regulation; 1 mV RMS ripple; Overvoltage Protection Modules optionally available; standard OV on low voltage units; 47-420 Hz input; 60°C operation; Automatic Current Limiting.

LVS/LVW Series: Low Power Slot & Wide Range Modules for systems use; UL Listed; .01% regulation; .5 mV RMS ripple; Overvoltage Protection Modules optionally available; 47-420 Hz input; 60°C operation; remotely programmable; remote sensing; Adjustable Auto Current Limiting.

TPW Series: Systems Modules, Wide Range. Two package sizes; UL Design; .02% regulation; 1 mV RMS ripple; Overvoltage Protection Modules optionally available; 47-420 Hz input; remotely programmable; remote sensing; Automatic Current Limiting.

TPZ Series: Systems Modules; Three package sizes; UL Design; .02% regulation; 1 mV RMS ripple; Overvoltage Protection Modules optionally available; standard OV on low voltage units; 47-420 Hz input; 40°C operation; remotely programmable; remote sensing; Automatic Current Limiting.

TP3E/TP3G Series: Triple Output Module; UL Listed; .02% regulation; 2 mV RMS ripple; built-in sequencing option; Overvoltage Protection Modules optionally available; 47-420 Hz input; 50°C operation; Automatic Current Limiting.

LHS Series: Half Rack, Sub-Rack Modules with meters and controls optionally available; UL Listed; .01% regulation; .5 mV RMS ripple; Internal Overvoltage Protection optionally available; 47-420 Hz input; 60°C operation; remotely programmable; remote sensing; Adjustable Auto Current Limiting.

L3R/L5R Series: Full Rack Systems Power Supplies; UL Listed; .005% regulation; .5 mV RMS ripple; .01% high stability standard; Automatic Load Share Paralleling; CV/CL Mode Light; Overvoltage Protection optionally available; 47-65 Hz input; 60°C operation; remotely programmable; remote sensing; Adjustable Auto Current Limiting.

VP Series: Full Rack Systems Power Supplies; UL Design; .05% regulation; 1 mV RMS ripple; Automatic Load Share Paralleling; Overvoltage Protection optionally available; remotely programmable, remote sensing; Adjustable Auto Current Limiting.

FT/FTR Series: Fixed Output Modules and rack mount version with ON-OFF switch; ±1% line regulation; 60 Hz input; 55°C operation; Automatic Current Limiting.

POWER SUPPLY SELECTOR & PRICE LIST

Systems Modules

Voltage (Nominal)	Voltage Range VDC	Max.[3] Current Amps	Package Size	Price $ Non Metered	OV Option $	Model[1] (See page 4)
Wide Range	0 to 12	1.4	B	85	30[2]	LVW12-1.4
	0 to 12.5	3.3	C	116	30[2]	TPWC12-3.3
	0 to 12.5	9	E	163	40[2]	TPWE12-9
	0 to 20	1	B	85	30[2]	LVW20-1
	0 to 50	0.32	B	85	30[2]	LVW50-.32
	0 to 52	1.2	C	116	30[2]	TPWC50-1.2
	0 to 52	3.2	E	163	40[2]	TPWE50-3.2
	Dual TPZD Ratings[6]		E	250	40[2]	TP2E
Multi-Output	10 to 26	1.8		–	–	
	5 to 16	1.5		–	–	(3 output)[4]
	3.2 to 5.5	6	E	195	STD	TP3E
	or					
	3.2 to 5.5	18	G	295	STD	TP3G
5	2.5 to 5.5	2.1	B	107	30[2]	LVS4-2.1
	2.5 to 5.5	6.5	C	127	STD	TPZC5-6.5 OV
	2.5 to 5.5	10	D	144	STD	TPZD5-10 OV
	2.5 to 5.5	20	E	188	STD	TPZE5-20 OV
	3.2 to 6.0	1.25	A	88	STD	TPSA6-1.25 OV
	3.2 to 6.0	5	C	115	STD	TPSC6-5 OV
	3.5 to 6.5	5.4	C	127	STD	TPSC6-5.4 OV
	3.5 to 6.5	8	D	144	STD	TPZD6-8 OV
	3.5 to 6.5	16	E	188	STD	TPZE6-16 OV
	6	25	¼ Rack	162	–	FTR6-25
	4.5 to 7.8	1.9	B	107	30[2]	LVS6-1.9
8	5.5 to 8.5	4.7	C	126	30[2]	TPZC8-4.7
	5.5 to 8.5	7	D	141	40[2]	TPZD8-7
	5.5 to 8.5	13	E	177	40[2]	TPZE8-13
	6.5 to 10.5	1.6	B	116	30[2]	LVS8-1.6
10	8.5 to 11.5	1.7	B	116	30[2]	LVS10-1.7
12	7.5 to 12.5	4	C	116	30[2]	TPZC12-4
	7.5 to 12.5	6	D	130	40[2]	TPZD12-6
	7.5 to 12.5	11	E	163	40[2]	TPZE12-11
	12	15	¼ Rack	162	–	FTR12-15
	11 to 15	1.4	B	107	30[2]	LVS12-1.4
	±11.5 to 15.5	2X0.5	A	82	30[2]	TPSA15D-.5[5]
	11.5 to 15.5	0.75	A	77	30[2]	TPSA15-.75
	±11.5 to 15.5	2X1.8	C	118	30[2]	TPSC15D-1.8[5]
	11.5 to 15.5	3	C	104	30[2]	TPSC15-3
	11 to 16	3.6	C	116	30[2]	TPZC15-3.6
	11 to 16	5.5	D	130	40[2]	TPZD15-5.5
	11 to 16	9.5	E	163	40[2]	TPZE15-9.5

Voltage (Nominal)	Voltage Range VDC	Max.[3] Current Amps	Package Size	Price $ Non Metered	OV Option $	Model[1] (See page 4)
15 to 18	13.5 to 20.5	1.1	B	116	30[2]	LVS18-1.1
	15	10	¼ Rack	190	–	FTR15-10
	15 to 19	8.5	E	177	30[2]	TPZE18-8.5
	18	10	¼ Rack	190	–	FTR18-10
24	16 to 26	2.5	C	116	30[2]	TPZC24-2.5
	16 to 26	3.8	D	130	40[2]	TPZD24-3.8
	16 to 26	6.4	E	163	40[2]	TPZE24-6.4
	18.5 to 27.5	0.8	B	107	30[2]	LVS24-.8
	24	8	¼ Rack	162	–	FTR24-8
28	22 to 30	0.5	A	77	30[2]	TPSA28-.5
	22 to 33	0.75	B	107	30[2]	LVS28-.75
	22 to 30	2	C	104	30[2]	TPSC28-2
	20 to 30	2.4	C	116	30[2]	TPZC28-2.4
	20 to 30	3.6	D	130	40[2]	TPZD28-3.6
	20 to 30	6	E	163	40[2]	TPZE28-6
	28	1	A	35	–	TPUA28-1
	28	7	¼ Rack	162	–	FTR28-7
	28	7.5	D	63	–	TPUD28-7.5
50	32 to 53	0.37	B	107	30[2]	LVS48-.37
	32 to 52	1.7	C	116	30[2]	TPZC48-1.7
	32 to 52	2.5	D	130	40[2]	TPZD48-2.5
	32 to 52	4	E	163	40[2]	TPZE48-4
	48	4	¼ Rack	162	–	FTR48-4
	50 to 63	1.4	C	126	30[2]	TPZC60-1.4
	50 to 63	3.3	E	184	40[2]	TPZE60-3.3
	50 to 83	0.25	B	123	30[2]	LVS65-.25
100	60 to 110	0.6	C	135	–	TPZC100-.6
	60 to 110	1.8	E	187	–	TPZE100-1.8
	80 to 126	0.18	B	131	30[2]	LVS100-.18
150	110 to 160	0.35	C	135	–	TPZC150-.35
	110 to 160	1.3	E	187	–	TPZE150-1.3
	150	1	¼ Rack	190	–	FTR150-1
	115 to 161	0.15	B	131	–	LVS150-.15
160 to 300	160 to 210	0.24	C	135	–	TPZC200-.24
	160 to 210	0.75	E	195	–	TPZE200-.75
	200	0.15	A	35	–	TPUA200-.15
	300	0.5	¼ Rack	190	–	FTR300-500

1. Detailed specifications for these units available on request.
2. OVS Modules available for LVS, LVW, and TP units. OVS Modules mount externally.
3. For TP and LVW Series current derates at low end of voltage range.
4. Includes three outputs: +3.2 to +5.5 VDC (OV) at 6A or 18A; +10 to +26 VDC at 1.8A; –5 to –16 VDC at 1.5A.
5. Dual Output modules.
6. Any two TPZD ratings in a TPZE package.

Quantity Prices Available – Consult Factory

Systems Racks

Voltage (Nominal)	Voltage Range VDC	Max. Current Amps	Package Size	Price $ Non Metered	Price $ Metered	OV Option $	Model** (See page 4)
5	2.5 to 5.5	25	½ Rack	314	364	56	LHS4-25
	2.5 to 5.5	40	3½" Rack	458*	478	75	L3R4-40
	2.5 to 5.5	70	5¼" Rack	532*	552	90	L5R4-70
	4.5 to 7.8	24	½ Rack	314	364	56	LHS6-24
	4.5 to 7.8	40	3½" Rack	458*	478	75	L3R6-40
	4.5 to 7.8	70	5¼" Rack	532*	552	90	L5R6-70
	4.7 to 5.5	135	5¼" Rack	595	645	80	VP5-135
8	6.5 to 10.5	21	½ Rack	341	391	56	LHS8-21
	6.5 to 10.5	25	3½" Rack	500*	520	90	L3R8-25
	6.5 to 10.5	50	5¼" Rack	580*	600	90	L5R8-50
10	8.5 to 11.5	21	½ Rack	341	391	56	LHS10-21
	8.5 to 11.5	25	3½" Rack	500*	520	75	L3R10-25
	8.5 to 11.5	50	5¼" Rack	580*	600	90	L5R10-50
12	11 to 15	18	½ Rack	314	364	56	LHS12-18
	11 to 15	25	3½" Rack	458*	478	75	L3R12-25
	11 to 15	50	5¼" Rack	532*	552	90	L5R12-50
	11 to 13	90	5¼" Rack	595	645	80	VP12-90
15 to 18	13.5 to 20.5	13	½ Rack	341	391	56	LHS18-13
	13.5 to 20.5	20	3½" Rack	500*	520	75	L3R18-20
	13.5 to 20.5	40	5¼" Rack	580*	600	90	L5R18-40
	14 to 16	85	5¼" Rack	595	645	80	VP15-85

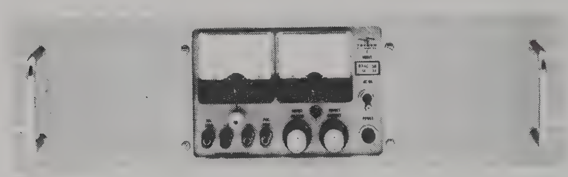
Voltage (Nominal)	Voltage Range VDC	Max. Current Amps	Package Size	Price $ Non Metered	Price $ Metered	OV Option $	Model** (See page 4)
24	18.5 to 27.5	10	½ Rack	314	364	56	LHS24-10
	18.5 to 27.5	15	3½" Rack	458*	478	75	L3R24-15
	18.5 to 27.5	30	5¼" Rack	532*	552	90	L5R24-30
	23 to 26	60	5¼" Rack	595	645	80	VP24-60
28	22 to 33	9	½ Rack	314	364	56	LHS28-9
	24 to 33	15	3½" Rack	458*	478	75	L3R28-15
	24 to 33	30	5¼" Rack	532*	552	90	L5R28-30
	26 to 30	50	5¼" Rack	595	645	80	VP28-50
50	32 to 53	5.8	½ Rack	314	364	56	LHS48-5.8
	32 to 53	8.5	3½" Rack	458*	478	75	L3R48-8.5
	32 to 53	17	5¼" Rack	532*	552	90	L5R48-17
	50 to 83	2.8	½ Rack	321	371	56	LHS65-2.8
	50 to 83	6	3½" Rack	510*	530	75	L3R65-6
	50 to 83	12	5¼" Rack	592*	612	90	L5R65-12
100	80 to 126	2.1	½ Rack	362	412	56	LHS100-2.1
	80 to 126	4	3½" Rack	545*	565	75	L3R100-4
	80 to 126	8	5¼" Rack	630*	650	90	L5R100-8
150	115 to 161	1.9	½ Rack	362	412	56	LHS150-1.9
	115 to 161	3	3½" Rack	545*	565	75	L3R150-3
	115 to 161	6	5¼" Rack	630*	650	90	L5R150-6

*This unit is normally stocked in metered version. NM (non-metered) units available on special order.
**Detailed specifications for these units available on request.

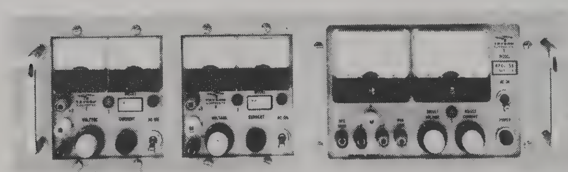
OPTIONS, ACCESSORIES & RACK ADAPTERS

For more details and price information — See Systron-Donner 1972-1973 Instruments Catalog or call your local Scientific Devices Sales Office listed on the back cover.

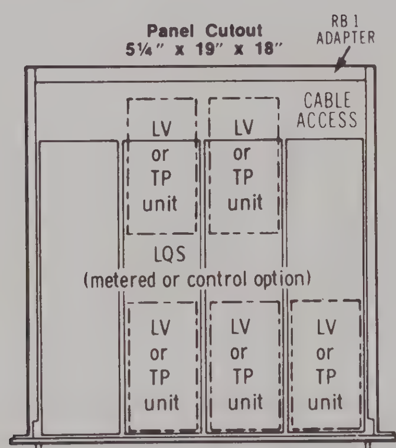
RPA-1



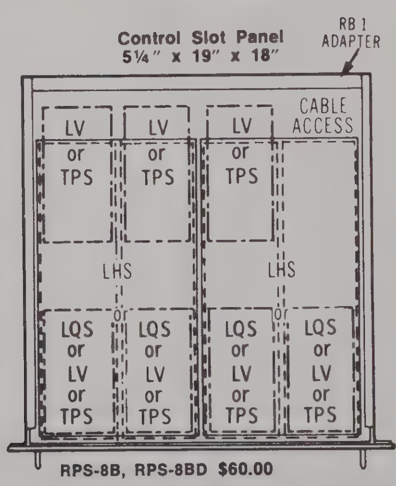
RHH-3



Typical panel mounts for Quarter Rack and Half Rack Laboratory Power Supplies

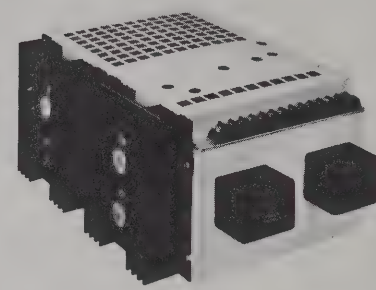


RAQ-4B $45.00



RPS-8B, RPS-8BD $60.00

Typical rack mount configuration for multiple output power systems



Super Trypack TP-E with OVS Modules

Overvoltage Protection Modules

Module	For Use With	OV Adjust Range	Price
OVS-1	Units to 12V	4V-22V	$30
OVS-2	Units to 28V	13V-50V	30
OVS-3	Units above 28V	40V-85V	30
OVS-4	Units to 12V	4V-22V	40
OVS-5	Units to 28V	13V-50V	40
OVS-6	Units above 28V	40V-85V	40

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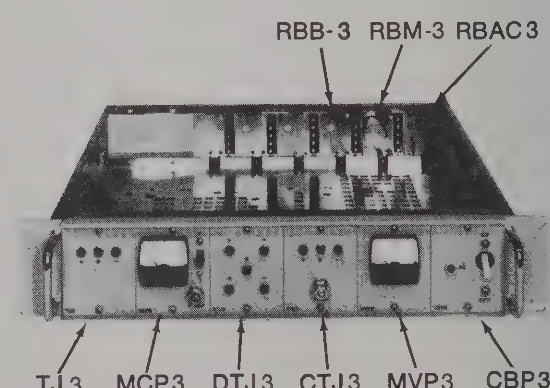

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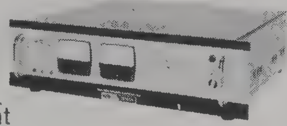

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14-16	85	VP15-85
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26-30	50	VP28-50

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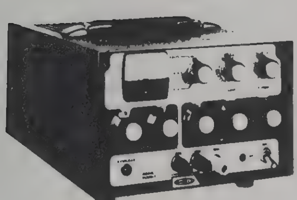

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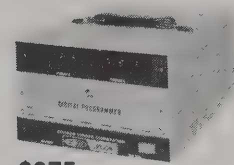

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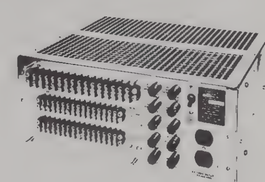

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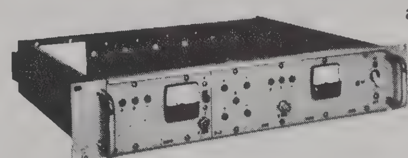

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Application Notes

These application notes have been prepared to aid the engineer in selecting a power supply to meet exacting specifications for laboratory and system requirements. On the following pages are described useful power supply applications as well as standard options, modifications and protective circuits relating to Trygon power supplies.

1. REMOTE VOLTAGE PROGRAMMING

One of the most commonly utilized external control characteristics of power supplies is that of remote control of the output voltage, which may be through the use of an external control resistance, or by an external voltage control. Most Trygon power supplies incorporate remote voltage programming features to enable this remote control of the power supply output, by either or both techniques.

A. Programming with Resistance Control

When the power supply is to be remotely controlled utilizing a resistance control, the external control resistor, in effect, replaces the internal power supply voltage controls.

In Trygon power supplies, the remote voltage programming characteristic will always be a linear direct function of the external control resistance.

Most Trygon power supplies use a 100, 500 or 1000 ohms/volt ratio for programming. The particular ratio is always specified on the applicable data sheet. Current through the programming resistor will always correspond to the inverse of the programming ratio, i.e. 100 ohms/volt=10 milliamperes, 500 ohms/volt=2 milliamperes.

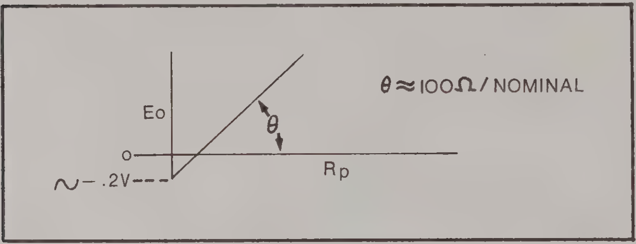


Figure 1-1. General Program Characteristic

The angle Ø or ohms/volt ratio is normally subject to small variances from nominal value, by 1% to 10%. On many models, Trygon can specially align the remote programming factors to reduce the zero offset or slope variation for specific applications. Please consult the factory for details.

For applications requiring greater programming ratio accuracy, the Trygon Super-Mercury Series can be used. These units feature ±1% accuracy of the 100 ohms/volt programming ratio.

Trygon power supplies provide either a two terminal or three terminal configuration for the remote programming mode. In those power supplies having the three terminal connection configuration, the third terminal is used to remove the internal power supply adjustments from the remote programming loop. These configurations may, of course, also be used in the two terminal mode. In the two terminal configuration, the internal power supply control potentiometers are always left in series with the external voltage programming resistance, and may be used as an additional adjustment or zero adjustment.

A typical set of connections for remote voltage programming with resistance is illustrated in Figure 1-2.

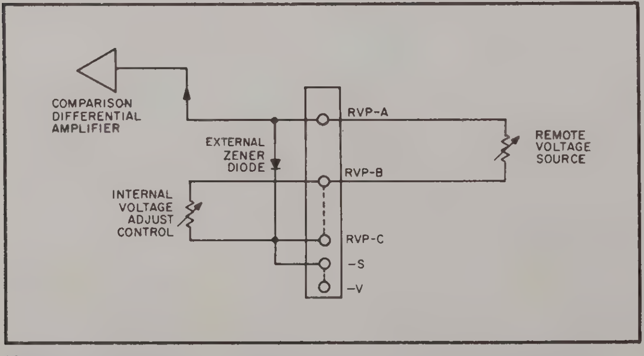


Figure 1-2. Remote Voltage Programming with Resistance

The programming resistor used should have a temperature coefficient of 20 ppm/°C or less and a conservative wattage rating to avoid changes of the resistance value due to heating.

When the leads to the programming resistor traverse electric fields, care should be taken to avoid pickup of ripple. It is recommended that a shielded two-wire cable be used with one end of the shield connected to the ground terminal of the power supply and the other end unconnected.

If the programming leads are of sufficient length to add appreciable resistance at the remote terminus, the power supply may be incapable of being programmed to zero input with a short circuit across the terminus. On most units, Trygon overcomes this problem by providing a small zero offset (negative voltage) with the programming terminals of the power supply shorted.

For remote programming using slot or narrow range power supplies, the programming resistance required is always calculated above the minimum output voltage of the unit. For instance, if the unit is rated at 24-32 volts output, as in the Trygon L3R28-15, to obtain 30 volts output, approximately 600 ohms would be inserted in the remote circuit (600 ohms at 100 ohms/volt=6 volts).

It should be noted that a small zener diode is externally included in the remote programming configuration to provide protection against the output voltage being inadvertently programmed above that which the system can tolerate.

B. Programming with Voltage Control

A second technique for remote control of the output voltage is possible on Trygon power supplies through the use of an external voltage control. Since the output voltage of the power supply is directly proportional to the current flow through the power supply internal divider network, it is practical to control the power supply output directly by means of a remote voltage control element, connected through the remote voltage programming terminals.

The circuit for this control is illustrated in Figure 1-3.

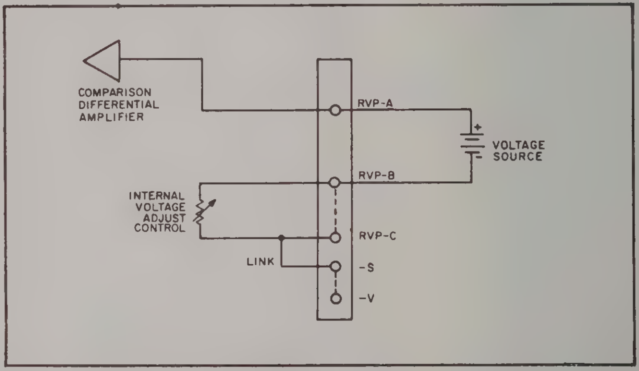


Figure 1-3. Remote Voltage Programming with Voltage Control

The power supply control ratio will always approximate 1 to 1, and the voltage source used should be capable of absorbing the approximately 10 milliamps of current flow in the control circuit. A battery, power supply, or low impedance operational amplifier may be utilized for this control. The required control voltage polarity is shown in Figure 1-3 for an NPN regulator. These polarities will, of course, be reversed in a germanium output power supply.

A further check on the required input polarity may be made by setting the unit into the remote programming mode of operation and measuring the internally generated voltage polarity across the remote program terminals. This will be of the same polarity as the required injected voltage.

For slot range units, the injected voltage must be decreased by the value of the low end minimum voltage. For example, assume that it is desired to voltage program an L3R28-15 Liberator power supply. Since the slot range of this unit is 24-32 volts, in order to obtain 30 volts, the injected voltage would be approximately 6 volts.

C. Programming Speed

During remote voltage programming, the supply is called upon to change both its voltage and current (assuming a fixed load resistor). The output voltage response time is related to the following items:

1. Output capacitor, C
2. Load resistor, R
3. Speed with which remote program elements are varied
4. Internal supply drive networks, i.e., RC networks, open loop gain, etc.
5. Direction of programming (higher or lower voltage)

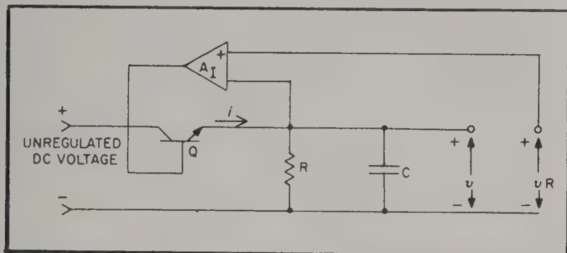


Figure 1-4. Simplified Voltage Regulator Circuit

A simplified voltage regulator schematic is illustrated in Figure 1-4, where:

v_R is the remote program source
v is the supply output voltage (load voltage)
A_I is the regulator open loop gain device (amps/volts)
Q is the series pass element
i is the series pass output current

First consider the situation where the remote program voltage, v_R rises abruptly as shown in Figure 1-5a.

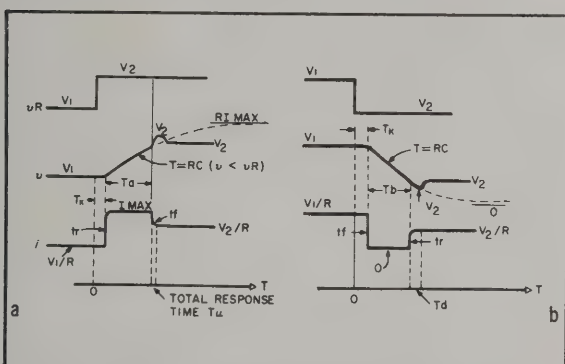


Figure 1-5. Speed of Programming, Response Waveforms

At $t(0^-)$ $v=v_R=V_1$ and $i=V_1/R$. At $t(0+)$ v_R rises to V_2. For a small time duration (several microseconds) the output voltage remains at V_1, which is caused by the inherent delay time, t_k of the open loop amplifier, A_I. After t_k, the amplifier is rapidly driven into saturation and Q, the series pass element, delivers its maximum (drive limited) output current, Imax and continues to do so, provided v is less than v_R. When i=Imax, v exponentially approaches the asymptotic value (Imax)(R) with a time constant T given by T=RC. However, when v is approximately equal to v_R the amplifier returns to its active region, the output voltage assumes its "new" steady state value V_2, and i decays to V_2/R. Note that a slight overshoot, V_2 is observed on the output voltage waveform, which is associated with the amplifier fall time, t_f.

Finally, when the supply is down programmed, the waveforms, shown in Figure 1-5b, are generally encountered. The waveforms shown in a and b of Figure 1-5 are quite similar with the notable exception that when v is greater than v_R in illustration b, i=0 and the output asymptotically approaches zero, an event which is independent of the "turned-off" series pass transistor, Q. Such is not the case in illustration a, where the "up-time" is related to Imax. In most instances T_u and T_d are composed chiefly of T_a and T_b, respectively. Also T_u is usually smaller than T_d.

2. REMOTE CURRENT PROGRAMMING

It is sometimes required to control the current output of a power supply from a remote position, either to alter the maximum current protection level or to operate as a constant current source. This control can be accomplished either by:

a. Direct Resistance Programming—applying a resistance to the proper rear terminals of a constant voltage/constant current supply with these specific terminal provisions, or
b. Indirect Programming—adding external control circuitry to a constant voltage programmable supply so that the output current can be controlled by means of a resistance or voltage applied to the remote voltage programming terminals.

A. Direct Resistance Programming

Most Trygon power supplies with adjustable current limiting have terminal provisions, marked RIP, that can be utilized for remote current programming. The range of current programming is from approximately 1% of the rated current to the full rated output.

The programming factor for the RS, HR, series is an inverse ratio, i.e., the higher the resistance the lower the current output. The programming factor of these supplies is approximately equal to $100\left(\frac{1-I_{load}}{I_{rated}}\right)$ ohms.

It is evident, therefore, that for a load current equal to the rated current, the programming resistor would be zero ohms (short circuit) and for minimum current limiting, approximately 100 ohms. A 125 ohm 2 watt low temperature coefficient variable resistor is recommended for full range programming.

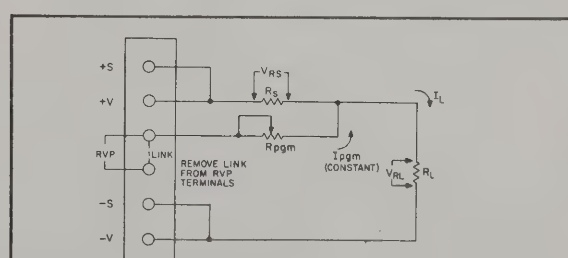
The programming factor for the Super-Mercury series is directly proportional to a factor of 500 ohms equivalent to maximum current, and zero ohms equivalent to minimum current. A 500 ohm 2 watt low temperature coefficient variable resistor is recommended for full range programming.

B. Indirect Programming

Due to the compactness of design, adjustable current limiting and current programming are not always built into a power supply. However, with the addition of an external current sensing resistor, the remote voltage programming capability of the supply can be used for current programming.

It is also possible to improve the current regulation of a multipurpose power supply with automatic voltage current crossover characteristics by utilizing this external current sensing resistor method. With this procedure, the current regulation will approach that of the specified voltage regulation, and can usually be improved to .05% or 1 milliampere.

The circuit required to achieve current programming is shown in Figure 2-1.



$$I_{pgm} = \frac{1}{\text{VOLTAGE PROGRAMMING FACTOR}} = \frac{1}{\text{OHMS / VOLTS}}$$

$$R_S = \frac{(V_{out} - V_{RL}\,MAX)}{(I_{RL} - I_{pgm})}$$

$$R_{pgm} \approx \frac{V_{RS}}{I_{pgm}}$$

V_{out} = OUTPUT at +V, −V TERMINALS

Figure 2-1. Current Programming Circuit (Indirect)

From Figure 2-1, it can be seen that with a constant load, I_L is directly proportional to Rpgm.

For optimum operation, Rs should be chosen so that V_{RS} is 1 to 2 volts. The maximum voltage available at the load will be the supply's rated output less this voltage drop.

For exact terminal numbering refer to the specific data sheet of the power supply being used.

To remotely program or obtain a constant current from a slot range power supply such as Trygon Model TPZC12-4, 7.4 to 12.5 volts at 4A, assume that it is desired to obtain a constant current of 1 ampere through approximately a 0.1 ohm load. At the highest voltage setting of the TPZC12-4 of 12.5 volts, a drop of 12.5 volts must be achieved between the +V terminal of the supply and the load. Therefore R_s must be 12.5 ohms.

The programming resistor R_{pgm}, since programming current of this unit is 2mA will be 25 ohms.

To decrease current, decrease the output voltage with R_{pgm}. The dynamic range of current adjustment will be 0.5 to 1 amp.

Since for this particular example the voltage adjustment range is approximately 50% of the highest output voltage, the current adjustment range will also be limited to approximately 50% of maximum.

Caution must be exercised never to exceed the voltage rating limits at the output terminals. Damage to the supply can be caused under this condition. By using a unit with fixed overvoltage protection, damage to the supply can be prevented under virtually all conditions.

3. REDUNDANT POWER SUPPLY SYSTEM

A redundant power supply configuration should be used in ultra-high reliability applications where a power supply failure would result in an intolerable system shut-down.

Trygon power supplies are ideally suited for redundant system operation because of their wide range voltage capabilities and ability to remote sense for large voltage drops.

A redundant power supply system is comprised of two (or more) power supplies connected such, that in the event of a power supply failure in either unit, the remaining unit(s) will almost instantly assume the burden of supplying the full load current, thus preventing the effects associated with a loss of power. To achieve ultra-high reliability, it is necessary to provide "reserve power" in the form of an additional power supply(ies).

A redundant power supply system may also be used to obtain protection from a power line failure when two separate power lines are available. This ultimate in reliability, designated as a dual-redundant configuration, provides complete protection against an AC power line failure (when standby power is available) as well as power supply failure.

To obtain optimum performance (a 50mv typical drop for approximately 800 microseconds in the event of a power supply failure) when the redundant configuration is used, it is necessary to modify the basic power supply. Therefore, it is essential that the redundant capability be specified when ordering a power supply. Field modification of most standard Trygon power supplies to permit redundant operation is possible but not recommended because of the required mechanical changes. However, if a redundant system is necessary and must be accomplished with existing units the diagram and instructions of Figure 3-1 must be carefully followed.

Figure 3-1 shows the modification and interconnections required on a standard Trygon power supply to provide redundant operation.

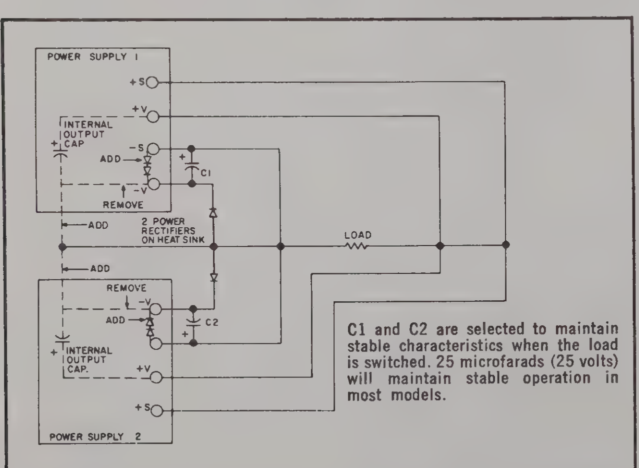


Figure 3-1. Redundant Power Supply Configuration

In modifying a power supply and connecting for redundant system operation, it is important to note that:

1. In most cases the additional isolating power diode can be incorporated within the power supply package.
2. The negative lead of the output capacitor must be disconnected from the −V terminal and brought out from the supply to the common junction of the power diodes.
3. Capacitors C1 and C2 are added as shown in the diagram.
4. Two low level diodes must be wired in series with each other and connected between the −S and −V terminals of each supply as shown. In most Trygon power supplies, one diode exists between these terminals and therefore only one additional diode should be wired in series with the existing diode.

A. Adjustment of Controls

1. With power supplies interconnected as shown, set the current adjustment controls on both units to their maximum current position (fully CW), adjust the output voltage controls on both units to provide the desired output voltage and an approximately equal current contribution from each power supply.

Note that the adjustment for equal current contribution is very critical since the power supply having the higher output voltage (even 1mv higher) tends to furnish the complete load current. For this reason it is completely acceptable for one unit to furnish the entire load current under normal operation.

4. PARALLEL OPERATION OF POWER SUPPLIES

Two or more power supplies may be connected in parallel when a greater current than that obtainable from a single power supply is required. Paralleling of supplies is not recommended unless the supplies contain automatic or foldback current limiting. Current limiting prevents damage to the supply by large circulating currents resulting from any difference in voltage. Most Trygon power supplies contain current limiting with automatic-crossover for direct paralleling operation or contain circuitry for auto-load share paralleling.

A. Auto-Load Share Paralleling

Power supplies in the Liberator, ValuPower Super-Mercury, CR and certain other series may be connected in parallel with one unit as the master and its voltage adjust control automatically setting the other slave units to the same output voltage. As many as four supplies may be paralleled.

The output currents can also be adjusted, on many of these units, so that all of the paralleled supplies will share equally of the current required by the load.

A typical parallel connection is shown in Figure 4-1 for power supplies of the Liberator Series.

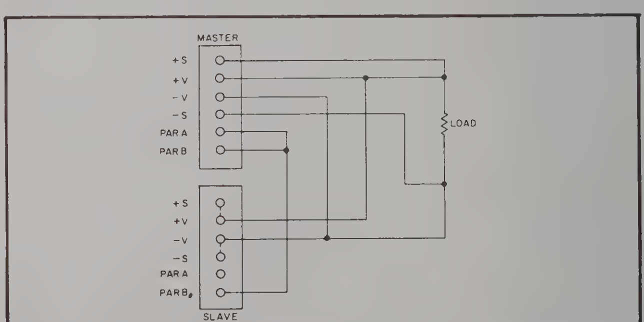


Figure 4-1. Auto-Load Share Parallel Connections

B. Direct Paralleling (Brute Force)

For direct paralleling, supplies need not have the auto-parallel feature described in paragraph 4A, nor be of equal ratings or be of the same series.

The two supplies to be paralleled should be set to approximately the same output voltage and their respective plus and minus terminals connected together. Current to the load will be drawn from the supply that is at a higher voltage until it goes into current limiting and its voltage decreases to that of the other supply, at which time the second supply will contribute to the current demand. Regulation of the combination will, naturally, be affected by any difference in setting of the two supplies.

The following are some precautions which must be noted in parallel operations:

1. The inherent load regulation of the direct parallel-connected supplies is equal to the nominal regulation of the individual supply plus the difference between the nominal voltage setting of the two supplies.
2. When direct parallel-connected supplies are used in a systems application, it is advisable to turn on both units simultaneously. The inputs of both supplies should be connected to a single circuit breaker.
3. When two supplies are operating in direct parallel it is not advisable to set either voltage control near zero since this would cause severe damage to the control.

5. SERIES OPERATION OF POWER SUPPLIES

Two or more power supplies (of the current limiting or constant current type) may be operated in series to obtain higher voltages than normally available from a single supply.

Interconnections required to achieve series operation are shown in the diagram below.

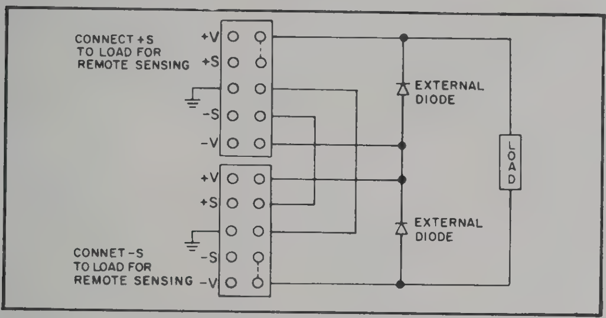


Figure 5-1. Connections for Series Operation of Two or More Power Supplies

Each supply should have its +S, +V, −S and −V terminals jumpered as shown. These terminals should be removed from chassis ground. A diode, capable of handling the short circuit current, is connected anode to minus and cathode to plus across each supply. These diodes provide a low impedance path when the load is shorted. (Most Trygon power supplies contain this diode as part of their standard circuitry.)

When two supplies are series-connected it is not advisable to operate at voltages greater than 500 volts, thereby avoiding the possibility of capacitor and transformer breakdown. Normal current regulation and limiting may be achieved by setting the current adjustment control on each supply to the desired value.

To prevent ripple and circulating ground currents, it is advisable to connect the chassis ground terminals together.

Note that the sensing terminals on the common terminals are connected together and only one of the common voltage terminals is connected to its sensing terminal. This is done to insure that the rated voltage regulation is maintained at the load when using remote sensing.

A. Auto-Series Operation

Auto-Series (automatic series) operation of power supplies will permit equal or proportional voltage sharing under all rated load conditions. Control of the output voltages will be controllable by one knob control of the designated master power supply. Auto-Series connections are available on units so designated on their applicable data sheets such as the Super-Mercury series. Other models not so designated, can be provided with this feature as an option.

Figure 5-2 illustrates the circuit principle involved.

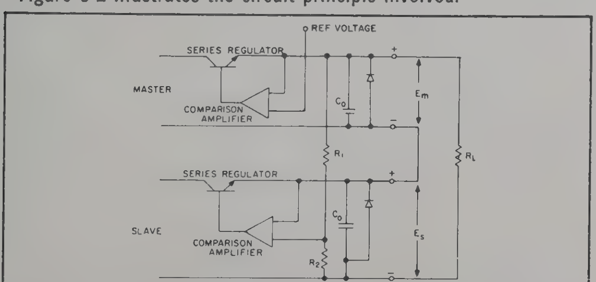


Figure 5-2. Connections for Auto-Series Operation of Two Power Supplies

The Slave power supply is connected in series with the negative output of the Master power supply. An internal voltage divide network, R_1 and R_2, is across the total output terminals in series. The inputs of the Slave comparison amplifier are taken at the junction of R_1 and R_2 and its positive output terminals. Since the Slave's normal feedback action is to maintain a zero error between the comparison amplifier's two inputs, the Slave supply will adjust itself to contribute the fraction of the total output as determined by the R_1 and R_2 divider network. Adjusting the voltage control of the Master power supply will result in a continual variation of the total series output.

B. Master-Slave Tracking

Master-Slave tracking is similar to Auto-Series operation except that the Master and Slave supplies feed independent loads of opposite polarity. This will insure a fixed relationship between the absolute values of the opposite voltages regardless of voltage changes caused by loading or adjustment settings.

Figure 5-3 illustrates the typical interconnections for Master-Slave Tracking in the Super-Mercury Series.

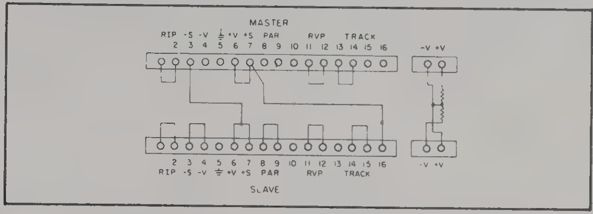


Figure 5-3. Master-Slave Tracking Interconnections

6. REMOTE SENSING

Remote sensing circuits enable the specified regulation to be maintained at the load by permitting the regulator circuits to sense the output voltage at the load. Trygon power supplies, with remote sensing, will compensate a voltage drop of about 0.5 volts in each leg, automatically. If voltage drops greater than this are anticipated, contact the Trygon Applications Engineering Department.

The following precautions and suggestions apply to remote sensing lead connections for Trygon Power Supplies:

1. The use of a twisted shielded pair is recommended to minimize inductive pickup.
2. Number 18 AWG wire may be used. Sensing lead current is about 100ma per leg.
3. Ground the sensing lead shield at the power supply end only to minimize noise pickup.
4. Load current must not be allowed to flow in sensing leads since it will damage the supply. Therefore, when switching leads with the power supply energized always connect the load lead first and then the sensing leads.
5. To avoid pickup of spurious signals and RF noise by the sensing leads, check the output of the supply with a scope to determine the presence of high frequency spurious signals. To eliminate these spurious signals, if they exist, bypass the RF to ground by connecting a capacitor to ground from the remote sensing terminals and/or across the sense terminals. Use the minimum possible value of capacitance since high values will increase the recovery time of the supply.
6. In any power supply system using remote sensing, load on-off switching will result in an overvoltage condition when voltage drops are present in the load leads. Rated voltage at the load is maintained by charging the power supply output capacitor to $E_{CO} = E_0 + IR_{lead}$. E_0 is the load voltage and IR_{lead} is the voltage drop. When the load is switched off, E_{CO} appears at the load end of the output leads. It is higher than the programmed voltage by an amount equal to the voltage drop. The duration of the overvoltage condition depends on the output capacitance and the bleeder resistance of the supply. The overvoltage can be reduced by a capacitor at the load. This capacitor, however, forms an RC circuit with the lead resistance, the time constant of which increases the duration of the overvoltage transient and also lengthens the response time of the supply.
7. On most supplies (modules excluded) diodes protect the power supply against damage resulting from open circuit sensing leads. If the sense line were to open while the load leads remain connected to the load, the voltage will rise by an amount equal to the difference between the diode saturation voltages and the voltage drop in the load leads.

If these precautions and suggestions are observed, the remotely sensed load voltage will meet specifications for line regulation, static load regulation, temperature coefficient and stability.

A. DC Wire Loss Considerations

The result of wire losses of the load lines is best shown by an example: Consider a Trygon Model HR20-10B Medium Power Half Rack, rated at 20 volts at 10 amps. Load regulation is specified as 0.01% or 2 mv. If the load wire is connected to the supply by three feet of AWG #12 wire (a total of six wire-feet), the voltage drop in the leads would be approximately 60 mv at 4 amps.

The Cable Voltage Drop Table is provided so that the line voltage drop can be readily determined. This table is conservative and is based on a cable temperature of 60°C which takes into account self-heating of cable copper. Note that the table gives voltage drop in ampere-feet.

	WIRE SIZE							
	#2	#4	#6	#8	#10	#12	#14	#16
AMPERE FEET	VOLTAGE DROP (VOLTS)							
2000	0.4							
1000	0.2	0.3						
900	0.18	0.27	0.4					
800	0.16	0.24	0.36	0.56				
700	0.14	0.21	0.3	0.49				
600	0.12	0.18	0.27	0.42				
500	0.1	0.15	0.225	0.35	0.6			
400	0.08	0.12	0.18	0.28	0.48			
300	0.06	0.09	0.135	0.21	0.36	0.54		
200	0.04	0.06	0.09	0.14	0.24	0.36	0.6	
100	0.02	0.03	0.045	0.07	0.12	0.18	0.3	0.45

Ampere Feet = Load Current in Amperes times the distance in Feet from Power Supply to Load.

Figure 6-1. Cable Voltage Drop Table

7. PROTECTION CIRCUITS

Dependable safeguards, properly used, can guarantee dependable service and long life for any power supply. Trygon has, through years of experience, provided many safeguards and protective circuits in its power supplies which have been proven through many thousands of hours of continuous and dependable service.

A. Overvoltage Protection

An important primary safeguard for sensitive circuits is overvoltage protection. The operating characteristics of normal transistor power supplies cause the output voltage to rise for many types of internal component failure. While Trygon's careful design and thorough quality control eliminate many causes of supply malfunction, there is no practical way to guard against random component failure. Consequently, overvoltage protection is deemed necessary when powering expensive voltage sensitive components such as integrated circuits, over a long period of time.

Trygon pioneered fail/safe overvoltage protection circuitry and holds basic U.S. Patent protection in this area, No. 3,163,814. Trygon's OV protection circuit protects against the following overvoltage conditions.

1. Overvoltage Caused by Component Failure in the Power Supply—If a component should fail in the power supply, such as a transistor in the series pass, that would cause the output voltage to rise, the overvoltage protection circuit would be activated and place a nominal short circuit across the output of the supply within 10 to 50 microseconds.
2. Overvoltage Caused by a High Voltage Externally Applied to the Output of the Power Supply—If a high voltage, of the same polarity as the supply output, is placed across the output of the supply, the overvoltage circuit will also be activated. In this way, the power supply is protected against damage caused by an external voltage.
3. Short Term Overvoltage Conditions Caused by Line or Load Transients—If a severe voltage transient is transmitted through the AC line and causes the output voltage to rise, or if the power supply load feeds back a voltage transient, the OV circuit will be activated and a short circuit placed across the output of the supply.

B. Operating Characteristics of Trygon OV Circuits

It has been established that, by far, the largest proportion of overvoltage conditions for well designed supplies is caused by line or load transients. Since short term overvoltage conditions cause the same damage to voltage sensitive components as long term overvoltage phenomena, it is vital that the OV circuit trigger with the shortest possible voltage transient. Trygon OV circuits will activate within 10 to 50 microseconds, being somewhat dependent on the pulse height and width of the transient. Desensitizing and delay circuitry is incorporated to meet specific applications where necessary to offset noisy system lines. Adjustable overvoltage protection and automatic tracking overvoltage protection on most Trygon supplies have the special feature of turning off the series pass, thereby preventing overdissipation of the crowbar SCR should the OV condition be permanent or repetitive.

C. Self Restoration

When the OV condition is removed, i.e., the transient has disappeared, many of the Trygon OV circuits will AUTOMATICALLY and INSTANTANEOUSLY restore the power supply to the normal operating mode. Thus, a transient will cause only a temporary disruption of the output voltage to protect the load circuit and/or the power supply, and then reset itself to provide normal power. This is particularly important for unattended systems which, with non-reset OV circuits, could be shut down for a long period of time.

D. Types of OV

Trygon features three different types of OV circuits which incorporate the above characteristics. The basic difference between these three types is the setting method for OV firing points.

1. Adjustable Overvoltage Protection—In this circuit, a potentiometer setting is provided (either internally in an accessible position, or on the rear panel of the supply) that limits the maximum output voltage of the power supply. If for any reason, including adjustment of the front panel voltage controls, the output voltage tries to rise above the preset value, the overvoltage circuit is triggered.
2. Automatic Tracking Overvoltage Protection—In this circuit, a tracking device automatically sets the overvoltage trigger point 10% (or 1.5 volts) above the programmed output of the power supply.* Thus, protection is maintained automatically over the entire voltage output range without the necessity of overvoltage trigger point readjustment. This feature is applicable even in remote programming applications. Special precautions must be utilized when rapidly "down" programming since this will appear as an overvoltage condition. Figure 7-1 illustrates a typical tracking overvoltage circuit.

* For settings of over 6V, this would be 20% (or 2 Volts).

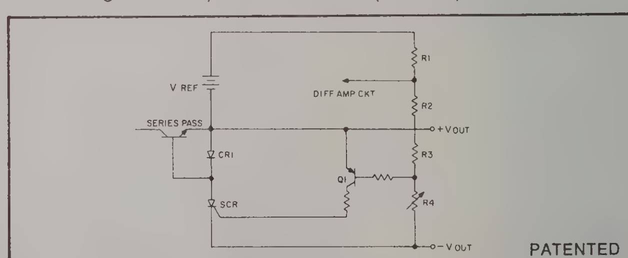


Figure 7-1. Typical Tracking Overvoltage Circuit

In normal operation, Transistor Q1 is in the non-conducting state. The voltage drop across the constant current divider of R1, R2 and R3 places the emitter and base of Q1 at the same potentials. Even if the output adjust control R4 were readjusted, the equipotentiality would be maintained. If a voltage of a higher potential should appear on the output terminals than that which the supply is programmed for, either from an external source or internal failure of the power supply, the emitter of Q1 will become more positive than its base and Q1 will conduct. The conduction of Q1 will gate on the SCR placing a short circuit crowbar across the output terminals. The current flowing through the SCR will forward bias diode CR1, effectively shorting the series pass sections base to emitter, reducing the series pass conduction to almost zero.

3. Fixed Overvoltage Protection—In this protection method, the overvoltage trip point is factory preset by selection of components and is not adjustable. This is generally established by a factory installed zener diode acting as the sensing device for SCR crowbar triggering.

CAUTION

Overvoltage Protection should not be generally used for applications of constant current or battery charging, since the action of the overvoltage circuit will extract energy from the load, causing possible damage. Where absolutely required, an additional series diode may be inserted between the overvoltage circuit and the load.

8. SHORT CIRCUIT AND OVERLOAD PROTECTION

All Trygon power supplies are provided with complete and automatic protection against short circuits and overloads. Five different methods are used, depending on the circuit requirements and application of each model.

A. Automatic Adjustable Current Limiting (ACL) automatically and continuously compares the load current with a reference previously established by adjustment. In the event of a short circuit or overload condition, the output current is limited to the preselected value. When the short or overload condition is removed, the supply automatically returns to normal operation as a constant voltage supply.

This method of current limiting permits the power supply to be operated as either a constant voltage or constant current supply. Since the power supply is provided with independent sensing circuits for current and voltage, the crossover point or transition between constant voltage and constant current is very sharp as shown in the illustration. In addition, mode indicator lights are provided on many units to indicate that the supply is in the current limiting mode.

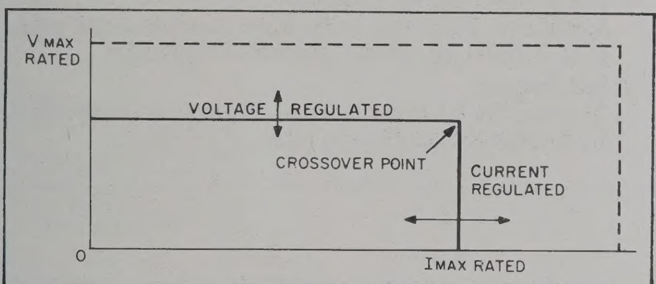


Figure 8-1. Automatic Adjustable Current Limiting Characteristic

Most Trygon power supplies of this type are also fully specified for regulation, ripple and other characteristics in this constant current mode.

B. Current Limiting (CL) is similar to automatic adjustable current limiting except that the crossover point is not as sharply defined. When precise constant current operation is not an application criteria, current limiting suffices to protect both the load and the supply from excessive currents. This type of protection is normally preset to rated maximum load current.

C. Automatic Electronic Switching (AES) short circuit protection automatically cuts off the output current, in the event of a short or overload, by electronic switching. The short circuit protection switching time is of the order of 1 millisecond. Power supply operation is restored by simply turning the AC Power off and then on.

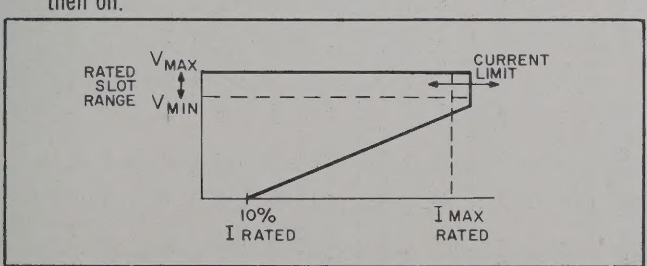


Figure 8-2. Automatic Adjustable Current Foldback Characteristic

D. Automatic Adjustable Current Foldback (FB) provides an automatic current limit below which the current and compliance voltage will "foldback", linearly, to approximately 10% of the rated current. Narrow or "slot" range supplies often use this economical protection method which still allows operation into incandescent, capacitive or battery loads.

E. Fuse and Circuit Breaker Protection, although not generally used for output protection, is provided on all Trygon power supplies for AC power input protection. (Except for modules and the FT Series.)

F. Reverse Voltage Protection acts to prevent damage to the supply when an externally applied high voltage of opposite polarity is placed across the output of the supply. A reverse voltage protection diode, preset in all Trygon power supplies, prevents damage to the supply. The current rating of this protection device is set at a value greater than the output rating of the supply. Failure mode of this device is usually in a short circuit condition, in the event of over-dissipation. This places a short across the output of the supply and ensures the protection function.

9. SEQUENCING AND INTERLOCKING

Certain applications, which use multiple voltages within a system, particularly if a memory system is involved, require that the applying or removal of any or all of the voltages occur in an orderly sequence. An out-of-sequence application of voltage can cause damage to the system circuitry, or improper "writing" of the memory.

Much like the high voltage vacuum tube circuitry that requires all low voltages and filament warm-up to be complete before the anode or plate voltage is applied; in modern computer information it is often mandatory that the IC main voltage be at a threshold before the auxiliary bias or operational amplifier voltages reach their threshold.

In memory circuits, this will prevent erroneous entries on to the memory core when turn-on occurs and, equally important, loss of memory or erroneous entries from turn-off or power failure conditions.

Typically, in a three-voltage system which has:

DC Output A: +5V for IC networks
DC Output B: +15V positive auxiliary voltage
DC Output C: −15V negative auxiliary voltage,

a sequencing capability will provide the following type of operation:

The +5 volt output is designed with a relatively large degree of internal AC storage, causing it to rise and fall at a rate of about 0.2 volts/millisecond, in the event of AC power loss.

In contrast, the +15 volt auxiliary outputs cannot rise faster or higher than the +5 volt output until the +5 volt output has reached a predetermined output threshold; i.e., nominally +4.75 volts; and will be crowbarred, rapidly, to zero should the +5 volt output decrease below the threshold level.

In addition to the basic overvoltage protection provided on each output individually, these overvoltages are so interlocked that the following will occur:

1. Until the +5V output comes up to threshold level the other outputs will not turn on.
2. Any failure of the +5V output causes immediate shutdown of all outputs.
3. If output B (+15V) goes into overvoltage, both output B and C (−15V) are turned off.

Option "S" provides these functions as a standard feature.

10. STANDARD FEATURES, OPTIONS AND MODIFICATIONS

Trygon manufactures, at present, over two hundred models of standard transistorized power supplies. In the great majority of applications, an exact fit to requirements may usually be found. On occasion, however, a requirement exists which can be met only by modifying a standard unit or fitting to it one or more of the standard options available. "Standard" options or modifications are those called for frequently enough that design and manufacturing methods have been worked out to permit ready inclusion of them in a standard unit. Many of these options are standard in certain models. Refer to the specific data sheet of the model required to see if the option is standard on that model.

A. Electrical Options and Modifications

1. Automatic Tracking Overvoltage Protection (OV) (Option)
   Trygon's unique, fully automatic, fail/safe, circuitry for protection of the load against voltages in excess of programmed voltage.
2. High Stability (X) (Option)
   Stability of 0.01% or 2mv with a temperature coefficient of $(0.01\% + 100\mu v)/°C$.
3. Super High Stability (XX) (Modification)
   Certain models can be furnished with a stability of 0.005% or 1mv with a temperature coefficient of $(0.005\% + 50\mu v)/°C$. For fixed voltage outputs the stability and time constant can be reduced to 0.002%. Consult the factory for details.
4. Master-Slave Tracking (Standard on M-C Super-Mercury Series units)
   Modification permitting interconnection of two or more power supplies so that the positive outputs and negative outputs maintain a fixed relationship once established, regardless of voltage change in either supply.
5. Slaving (Modification)
   Permits interconnection of two or more power supplies of the same output polarity so that the output level of all supplies is controlled by the "Master" unit.
6. Mid-Voltage Protection (Modification)
   Permits interconnection between supplies of a multiple supply system such that all supplies shut off when any of the other supplies lose output voltage.
7. Over and Undervoltage Protection (Modification)
   A protection system that shuts off the supply when the output voltage exceeds or drops below the set output voltage.
8. Multiple Outputs (Modification)
   Permits the supply to furnish additional DC outputs with the same or differing regulation, ripple, etc., or AC outputs, e.g., for filament power, etc.

B. Mechanical Options and Modifications

1. Meters or Elimination of Meters (Option and Modification)
   All rack-type supplies may be furnished with or without meters. MIL-M-10304B meters may be substituted if required.
2. Chassis Slides (Modification)
   Provisions for chassis slides or mounting of chassis slides can be accomplished on all Trygon Power Supplies. Integral slide mounting provisions are standard on many models.
3. Special Connectors (Modification)
   Special connectors may be mounted on the rear panel for AC input and DC output connection, as required.
4. Screwdriver Lock-Type Controls (Modification)
   Screwdriver lock-type controls can be substituted for knob type voltage and current controls, as required.
5. Special Handles (Modification)
   Special handles may be placed on the front panel of any Trygon power supply that is normally furnished with handles.
6. Special Front Panel (Modification)
   Special front panels may be furnished, including special paint, panel fasteners and oversize panels for RFI gasketing.
7. Rack Adapters
   Rack adapters are available for all Trygon power supplies that are not packaged in a 19" wide panel.

11. MILITARY SPECIFICATIONS AND RELIABILITY

A. Mil Spec Power Supplies

The following chart indicates military specifications utilized in establishing the performance design criteria of standard Trygon power supplies. Where required, Trygon can supply compliance data. Please contact the factory for details.

SPECIFICATION	HH	HR	DL	TL	L-R	VP	M-P	M-C	RS	CR	FT	TP	LV	LHS
Quality Control MIL-Q-9858	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Inspection MIL-I-45208A	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Temperature MIL-T-21200C(ASG) Proc. 1	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Temperature MIL-E-16400 Class 4	S	S	S	S	S	S	S	S	S	–	S	S	S	S
Temperature Shock MIL-E-5272C(ASG) Proc. 1	S	S	S	S	S	S	S	S	S	–	S	S	S	S
Vibration MIL-T-4807A Method 1A	S	S	S	S	S	S	S	S	S	–	S	S	S	S
MIL-Std. 167 Type I	S	S	S	S	S	S	S	S	S	–	S	S	S	S
Shock MIL-E-4970A Proc. II	S	S	S	S	S	S	S	S	S	–	S	S	S	S
RFI Conducted and Radiated MIL-I-6181	S	S	S	S	S	S	S	S	S	–	–	S	S	S
MIL-I-16910	S	O	S	–	S	S	S	S	S	–	–	S	S	S
MIL-I-26600	S	S	S	S	S	S	S	S	S	–	–	S	S	S
MIL-I-26600 Amend 10	S	O	S	–	S	S	S	S	S	–	–	S	S	S
Transformers MIL-T-27B Grade 6, Class S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Wire MIL-W-16878D	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Marking MIL-STD-130	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Circuit Board Material MIL-P-18177, Grade FR4, FR5 Flame Retardant	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Non-Fungus Nutrient Materials	S	S	S	S	S	S	S	S	S	S	S	S	S	S
UL Design	O	O	O	O	S	S	O	O	O	O	O	S	S	S
UL Approval (UL 478)	–	–	–	–	S	O	–	–	–	–	–	S	S	S

S indicates standard performance feature   O indicates optional performance feature   – indicates not available

B. Reliability and Meantime Between Failure

Optimum reliability is guaranteed throughout the production phase, of Trygon power supplies, by strict adherence to the Quality Assurance procedures of MIL-Q-9858. Only quality components are used in the manufacturing process. Power transistors are hermetically sealed silicon types. Zener diodes are temperature stabilized. Electrolytic capacitors are computer grade with rated life in excess of 10 years. Transformers meet or exceed the requirements of MIL-T-27B. All standard Trygon power supplies carry a 5 year warranty.

Mean Time Between Failure (MTBF) analysis is conducted in accordance with MIL-HDBK-217. The table below is a typical MTBF analysis performed by Trygon. MTBF calculation tables, as well as test data sheets are available for every standard Trygon power supply and will be furnished upon request.

RELIABILITY CALCULATION FOR POWER SUPPLY TPSA6-1.25 OV

PART DESCRIPTION	NUMBER OF UNITS PER SUPPLY (N)	ESTIMATED FAILURE RATE PER COMPONENTS* % FAILURE PER 1000 HRS. (λ)	ESTIMATED FAILURE RATE PER COMPONENT GROUP % FAILURE PER 1000 HRS. ($N\lambda$)
Silicon Diodes	10	.02	.200
Controlled Rectifiers (OV passive)	1 (non active)	.05	–
Germanium Transistors	None	.025	–
Silicon Transistors	3	.025	.075
Composition Resistors	12	.001	.012
Power Wirewound Resistors	3	.04	.120
Metal Film Resistors	5	.02	.100
Paper Capacitors	6	.003	.018
Aluminum Electrolytic Capacitors**	4	.035	.140
Transformers	1	.06	.060
Integrated Circuits	1	.04	.040
Low Population Parts	1 set	.3	.300

Mean time between failure MTBF $= 1/\Sigma N\lambda =$ 80,300 hours

$\Sigma(N\lambda) = 1.247$

Probability of survival for time T: $Ps = e - \Sigma(N\lambda)t$

Probability of operation for 2500 hours without failure:

$$Ps = e^{-(1.247 \times 10^{-5} \times 2500)} = e^{-.0312}$$

$$Ps = 96.9\%$$

*Reference: Handbook Reliability Stress and Failure Rate Data for Electronic Equipment, MIL Hdbk 217, dated 8 August 1962. Values based upon actual derating factors.

**Computer Grade

C. Special Requirements

Standard Trygon power supplies can be modified to meet special requirements. Trygon's unique manufacturing techniques and wide selection of standard units provide a capability for producing special power supplies at nominal costs, thereby avoiding the need for custom built units with their attendent high cost and delay. Many power supply users depend on the field-proven reliability record of power supplies engineered and manufactured by Trygon.

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